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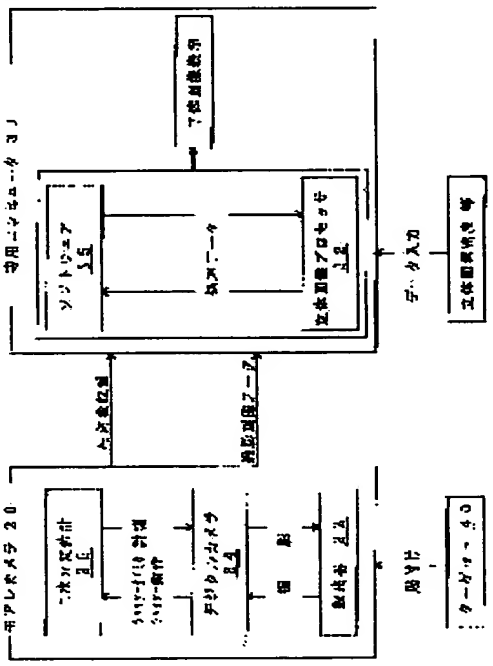
(54) DIGITAL THREE-DIMENSIONAL IMAGE MEASUREMENT SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To make it possible to obtain highly accurate stereoscopic images with simple measurement in a short time when displaying the image of an object to be measured which has a two-dimensional or three-dimensional shape.
SOLUTION: This system has a portable moire camera 20 which has a three- dimensional displacement gage 26 and a computer 30 to be exclusively used which has an image processor 32 for executing the arithmetic processing of the photographic image data of the object to be measured photographed by the moire camera 20. The relative displacement quantity in the objet to be measured is determined from the photographic image data by the three- dimensional displacement gage 26. Further, the sections having characteristic shapes and known shapes are extracted from the photographic image data and are respectively subjected to averaging processing by the computer 30 to be exclusively used and thereafter, respective pieces of the photographic image data are synthesized by the image processor 32, by which the stereoscopic images are obtained.



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JAPANESE [JP,2000-171924,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The portable digital camcorder which photos a device under test, In a digital three dimensional image gaging system equipped with the processing unit which carries out data processing of the photography image data of this device under test photoed with this digital camcorder, and the three dimentional display image [three dimensional image] processor based on this photography image data that carried out data processing A photography image acquisition means to photo a device under test and to obtain two or more photography image data with this digital camcorder, The image data data-processing means which incorporates and carries out data processing of two or more image data obtained with this photography image data acquisition means to this processing unit, The digital three dimensional image gaging system characterized by having a solid image creation display means to display the solid image which compounded and created each photography image data processed with this data-processing means.
[Claim 2] While using the digital camcorder equipped with the three-dimensions displacement gage with which said photography image acquisition means consists of a three-dimensions displacement pickup, a three-dimensions include-angle detector, and a three-dimensions acceleration detector A photography image data movement magnitude calculation means to compute the movement magnitude between these photography image data from said two or more photography image data with these detectors, The digital three dimensional image gaging system indicated from the movement magnitude computed with this calculation means to claim 1 characterized by having an amount calculation means of relative displacements to compute the amount of relative displacements of this digital camcorder and a device under test.
[Claim 3] A description configuration extract means to extract the part into which said image data data-processing means has the description configuration of a device under test in each of two or more photography image data obtained by said photography image acquisition means, A known configuration election means to elect known configurations, such as the shape of a circle configuration or a square, further from the description configuration extracted by this, A photography image data adjustment means to pile up the same parts of the description configuration part in each of two or more of these photography image data elected by this known configuration election means, or a known configuration, and to adjust these two or more photography image data, A three dimensional image gaging system given in claims 1 and 2 characterized by carrying out three dimensional image creation based on the photography image data adjusted by this, and said amount of relative displacements.
[Claim 4] The digital three dimensional image gaging system according to claim 1 characterized by attaching two or more auxiliary members on the front face of this device under test, and considering as the shape facility of a device under test when there is no part from which the shape of surface type of said device under test turns into the description configurations, such as irregularity, at a flat surface.
[Claim 5] It is a digital three dimensional image gaging system given in claims 1, 2, 3, and 4 characterized by attaching and photoing a three-dimensions displacement pickup on the front face of a device under test when said device under test is the movable body which is carrying out movable.

[Claim 6] The portable digital camcorder which photos a device under test, In a digital three dimensional image gaging system equipped with the processing unit which carries out data processing of the photography image data of this device under test photoed with this digital camcorder, and the three dimentional display image [three dimensional image] processor based on this photography image data that carried out data processing A photography image acquisition means to photo a device under test and to obtain two or more photography image data with this digital camcorder, A photography image data data-processing means to process using Space FFT for this data processing while incorporating and carrying out data processing of two or more image data obtained with this photography image data acquisition means to this processing unit, The digital three dimensional image gaging system characterized by having a solid image creation display means to display the solid image which compounded and created each photography image data processed with this photography image data data-processing means.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] In case this invention piles up in more detail two or more photography image data which photoed and obtained the device under test about a digital three-dimensions gaging system and gives a synthetic indication of the solid image, it relates to the digital three dimensional image gaging system which can display a highly precise solid image for a short time by carrying out data processing of this photography image data.
[0002]
[Description of the Prior Art] A CCD camera etc. is used in order to photo the device under test which has a 2-dimensional configuration or a three-dimensions configuration, to numerical-model-ize the photography image, or to display it as a solid image on screens, such as a computer, conventionally, and to raise the precision of the photography image data. The method of presentation of the solid image of a device under test using this CCD camera installs this device under test in the measuring point set up beforehand, and photos this device under test from two places while it installs this CCD camera in the pointing device which was able to be formed beforehand first. While obtaining two or more measure points for the pars convoluta lobuli corticalis renis of a device under test, the curvature for this pars convoluta lobuli corticalis renis is calculated, this photography image data that carried out computation is compounded, and the numerical model and solid image of this device under test are obtained from each of two or more photography image data obtained by this photography.
[0003] Moreover, there is a thing using an optical approach besides said approach. By this approach, after sticking two or more predetermined auxiliary objects on the front face of this device under test, light is irradiated to up to this device under test using the light source. While the reflected light arises on this device under test by this optical exposure, the light and shadow by this auxiliary object will arise, and a photograph is taken as it is also with a CCD camera about this. And detection processing is carried out to it being also with a digital image sensor about two or more photography image data obtained by this photography, two or more of these photography image data that carried out detection processing is compounded, and a solid image is obtained.
[0004]
[Problem(s) to be Solved by the Invention] However, time amount is taken [after the pointing device which installs this CCD camera is expensive, or installing a CCD camera in a pointing device in the approach of installing a CCD camera in the pointing device formed beforehand, and obtaining the solid image of a device under test since the configuration is large-scale as described above] to start photography. Moreover, since unreasonableness arose in photography if a device under test is not much large, since carrying of a CCD camera is difficult, there was a problem that the magnitude and the configuration of a device under test will be restricted.
[0005] In addition, in order to compute the curvature for the pars convoluta lobuli corticalis renis of a device under test from the photography image data which photoed and obtained said device under test, since the precision of the photography image data influences greatly, it is difficult to compute accurate curvature, and the calculation takes time amount further. Moreover, there was

a problem that dispersion appeared in the precision of the computed curvature and the precision of a solid image, and dependability was missing from how taking [number / the measure point location for the pars convoluta lobuli cortioalis renis of the device under test used for calculation of this curvature, / of the measure point] influencing calculation of said curvature greatly.
[0006] Furthermore, in the above mentioned optical approach, since a predetermined auxiliary object must be stuck on a device under test, time and effort is required, and by the time this also starts photography, it will require time amount. And since that pasting location influences the precision of a solid image greatly in case this auxiliary object is stuck on a device under test, as described above also in this approach, dispersion will appear in precision and dependability will be missing. moreover, it is difficult to be easy to produce an optical interference in the light used as the light source, in case an optical exposure is performed on the front face of a device under test and that light and shadow are acquired, and to make the effect by this optical interference mitigate — etc. — there was a problem.
[0007] Then, in obtaining the solid image of the device under test which has solid configurations, such as a 2-dimensional configuration or a three-dimensions configuration, the technical problem which this invention tends to solve is offering the digital three dimensional image gaging system which the precision's is raised and can obtain a highly precise solid image.
[0008]
[Means for Solving the Problem] In order to solve this technical problem, the digital three dimensional image gaging system of this invention The portable digital camcorder which photos a device under test, In a digital three dimensional image gaging system equipped with the processing unit which carries out data processing of the photography image data of this device under test photoed with this digital camcorder, and the three dimentional display image [three dimensional image] processor based on this photography image data that carried out data processing A photography image acquisition means to photo a device under test and to obtain two or more photography image data with this digital camcorder, The image data data-processing means which incorporates and carries out data processing of two or more image data obtained with this photography image data acquisition means to this processing unit, Let it be a summary to have a solid image creation display means to display the solid image which compounded and created each photography image data processed with this data-processing means.
[0009] According to invention of the above-mentioned publication, it has a three dimentional display image [three dimensional image] processor based on the photography image data by which this data processing was carried out to the processing unit which carries out data processing of the photography image data of this device under test to the digital camcorder which is a digital type and can be carried. While obtaining two or more photography image data with the photography image acquisition means by this digital camcorder Data processing of two or more photography image data obtained by this is carried out with the image data data-processing means by this processing unit, this photography image data is further compounded for this with a solid image creation display means, and a solid image is displayed. It becomes possible to be high degree of accuracy and to obtain the solid image of a device under test by this, for a short time, since data processing is possible for a short time while becoming possible to obtain photography image data with a sufficient precision.
[0010] And at this time, it is good to compute the movement magnitude between photography image data with a photography image data movement magnitude calculation means based on the detection value equipped with the three-dimensions displacement gage which becomes a digital camcorder from a three-dimensions displacement pickup, a three-dimensions include-angle detector, and a three-dimensions acceleration detector like invention according to claim 2 both according to these detectors, and to calculate the amount of relative displacements between this digital camcorder and a device under test from this movement magnitude further. Accurate photography image data will be obtained by this and a highly precise solid image will be obtained.
[0011] Furthermore, like invention according to claim 3, in each of two or more of said photography image data, the description configuration of a device under test is extracted with the description configuration extract means, and known configurations, such as the shape of a circle configuration or a square, are further extracted with a known configuration extract means.

And it is good to create the three dimensional image of a device under test with superposition, this piled-up photography image data, and said amount of relative displacements for the same parts of this extracted description configuration and a known configuration with a photography image data adjustment means. A solid image with adjustment of two or more image data effectively highly precise from the ability to also carry out ** with a sufficient precision will be obtained by this.

[0012] And when it is the movable body in which attaches two or more auxiliary members on the front face of this device under test, and makes the shape facility of a device under test, and said device under test is carrying out movable like invention according to claim 5 when there is no part from which the shape of surface type of said device under test turns into the description configurations, such as irregularity, at a flat surface like invention according to claim 4, it is good to attach and photo a three-dimensions displacement pickup on the front face of a device under test. Photography becomes possible, without choosing the configuration of a device under test, and the situation of a halt or movable ** by this, and it is efficient. Moreover, since the photography image data obtained by photography is also highly precise, a solid image highly precise as a result is obtained.

[0013] Moreover, the portable digital camcorder with which invention according to claim 6 photos a device under test, In a digital three dimensional image gaging system equipped with the processing unit which carries out data processing of the photography image data of this device under test photoed with this digital camcorder, and the three dimentional display image [three dimensional image] processor based on this photography image data that carried out data processing A photography image acquisition means to photo a device under test and to obtain two or more photography image data with this digital camcorder, A photography image data data-processing means to process using Space FFT for this data processing while incorporating and carrying out data processing of two or more image data obtained with this photography image data acquisition means to this processing unit, Let it be a summary to have a solid image creation display means to display the solid image which compounded and created each photography image data processed with this photography image data data-processing means.

[0014] According to invention of the above-mentioned publication, it has a three dimentional display image [three dimensional image] processor based on the photography image data by which this data processing was carried out to the processing unit which carries out data processing of the photography image data of this device under test to the digital camcorder which is a digital type and can be carried. While obtaining two or more photography image data with the photography image acquisition means by this digital camcorder Data processing of two or more photography image data obtained by this is carried out with the image data data-processing means by the space FFT of this processing unit, this photography image data is further compounded for this with a solid image creation display means, and a solid image is displayed. Since data processing is possible for a short time while this enables it to obtain photography image data with a sufficient precision, it becomes possible to obtain the solid image of a device under test in the much more high degree of accuracy and the much more short time.

[0015]

[Embodiment of the Invention] The gestalt of suitable 1 operation of this invention is hereafter taken for an example, and it explains to a detail with reference to a drawing. In addition, a moire camera shall be used for the digital-type video camera which photos a device under test in this example, and a device under test presupposes that it is the halt object which does not carry out movable. Drawing 1 shows the block diagram of the digital three dimensional image gaging system concerning the gestalt of 1 operation of this invention. This digital three dimensional image gaging system 10 is constituted by the moire camera 20 which divides roughly, photos a device under test 12, and obtains that photography image data, and the dedicated purpose computer 30 which processes that photography image data.

[0016] The three-dimensions displacement gage 26 for said moire camera 20 to compute the amount of relative displacements of MOAKAMERA 20 in the CCD digital camera 24 and this device under test 12 of the industrial use way which photos the projector 22 which irradiates the fringe (moire pattern) which is a grid pattern by shading of light on a device under test 12 at the

interior, and the this irradiated fringe is formed. In addition, it is constituted that the specification is also with a wired system with the precision of **0.1mm of photographic coverage 200mmx160mm and a solid image, a resolution [6/100], and a weight of 1.5kg.
[0017] Said projector 22 has glass with which said fringe (moire pattern) was prepared in the lens of the light source for performing that optical exposure, and this fringe is floodlighted on a device under test 12 by performing an optical exposure through this glass. And the condition of this fringe will be photoed by photoing a device under test 12 as said CCD digital camera 24 is also.
[0018] Moreover, said three-dimensions displacement gage 26 is constituted by the three-dimensions displacement pickup and three-dimensions include-angle detector which are not illustrated, and the three-dimensions acceleration detector. And a photograph is taken shifting little by little that the CCD digital camera 24 in which the device under test 12 which projected said fringe was formed by said moire camera 20 is also, and the movement magnitude (variation rate amount) of this moire camera 20 is computed with the same part of the device under test 12 in the photography image data. While calculating automatically the optimal timing for cutting the shutter in this CCD digital camera 24 based on this amount of displacement, continuous shutter actuation is performed automatically. In addition, this three-dimensions displacement gage 26 consists of wired systems with a% [of precision] of 3, and a weight of 300g.
[0019] Moreover, while said dedicated purpose computer 30 carries out data processing of the photography image data photoed with said moire camera 20, the image processor 32 which carries out synthetic processing of this photography image data that carried out data processing, and displays the solid image of three dimensions is formed. This moire camera 20 and this dedicated purpose computer 30 are incorporated serially automatically by connecting with the wired system to a dedicated purpose computer 30, and data processing of the photography image data of two or more device under tests 12 photoed with this moire camera 20 is carried out by this, and it is constituted so that it may be compounded in this solid image processor 32 after that.
[0020] In addition, also in case a photograph is taken as said device under test 12 is also with said moire camera 20, when it is the movable body which is moving, said three-dimensions displacement gage 26 and the same three-dimensions displacement gage which is not illustrated are attached on the front face of a device under test 12. And when the main ****** description has the configuration of said device under test 12 neither at a flat-surface configuration nor flatness, it is good to take a photograph with the same approach with having stuck two or more targets 40 which consisted of predetermined two-dimensional configurations or solid configurations as an auxiliary member of the configuration of a device under test 12 on the front face of this device under test 12, and having described this above again.
[0021] Drawing 2 shows the configuration of the digital three dimensional image gaging system 10 shown in said drawing 1 with the block diagram. In addition, the direction of an arrow head in drawing shows the I/O direction of data. The moire camera 20 is constituted by a projector 22, the CCD digital camera (digital camera) 24, and the three-dimensions displacement gage 26 so that it may illustrate. And as mentioned already, a photograph will be taken as a digital camera 24 is also about the fringe (moire pattern) floodlighted on the device under test 12 by the projector 22 formed in said moire camera 20, and data processing will be carried out to it being also with the software for analysis in which this photoed fringe was prepared by this moire camera 20 and which is not illustrated.
[0022] In addition, in case a device under test 12 is photoed as it is also with said moire camera 20, a near distance of the camera station of this moire camera 20 and the installation location of a device under test 12 is given beforehand. And it is good to take a photograph, moving so that the photography part of this device under test 12 may be overlapped as it is also with this moire camera 20.
[0023] And as are described above, and it overlaps, the amount of relative displacements in a device under test 12 is computed from include-angle change computed based on the migration length and this photography image data which the moire camera 20 moved from two or more photoed photography image data. The timing which cuts the shutter of the CCD digital camera

24 based on this computed amount of relative displacements is measured, and a shutter is out. In addition, all of measurement and shutter actuation of the timing which cuts these these shutters are performed automatically. While shutter timing is efficiently measurable with this, it becomes possible [the photography number of sheets] to press down to the minimum.
[0024] After said amount of relative displacements and the photography image data automatically photoed with said moire camera 20 are complemented in order to improve the detection precision of the space-coordinates location in this photography image, whenever 1 photography image data is obtained by the shutter actuation, it is serially sent to a dedicated purpose computer 30. However, it is constituted so that an operator may input that data, such as a voxel consistency in this case, are also at an interactive format.
[0025] And the part which has a characteristic configuration in the direction of a normal of photography image data [in / that it is also with the software 35 in said dedicated purpose computer 30 / said device under test 12] is extracted for every previous 1 photography image data. The extract of this description part extracts flat-surface configurations, such as the shape of music flat surfaces which are the projection parts in the configuration of a device under test 12 etc., such as an others and circle configuration, the shape of a cylinder and also a square, or a triangle, and the so-called known configuration.
[0026] However, although flat-surface configurations, such as the shape of the shape of a square or a triangle, are automatically extracted in the case of the feature extraction of said known configuration, an operator will do the selection extract of the so-called circle configurations, such as the shape of a polar plane or a cylindrical shape. In addition, although whenever [recognition / of whenever / distinction / of the circle configuration at the time of this feature extraction / the number to extract] changes with operators, by the time a solid image is finally obtained by some, its extract part, number of the circle configuration by which the selection extract was carried out here, etc., some time difference will arise by them.
[0027] And in each photography image data by which said extracted known configuration is photoed, equalization processing of the same known configuration is carried out using count of the least square method etc., and this known configuration calculates the amount of displacement most in agreement. While having this every one photography image data and piling up and compounding it on the solid image processor 32 based on the amount of displacement computed here, the solid image of three dimensions will be again displayed for this compound image on a dedicated purpose computer 30 on the screen of delivery and this dedicated purpose computer 30.
[0028] In addition, it is good to check whether it has the description which the configuration of this device under test 12 mentioned already on the occasion, for the configuration of this device under test 12 to stick two or more targets 40 on the front face of a device under test 12, when the description is not seen in a flat surface and a flat configuration, and to use for photography of said device under test 12 as a shape facility. Moreover, when this device under test 12 is a movable body, as mentioned already, a three-dimensions displacement gage is attached on a device under test 12. However, when the device under test 12 has stopped, this three-dimensions displacement gage may be omitted, without attaching.
[0029] Moreover, you may make it deliver and receive transfer of data, such as photography image data photoed with said moire camera 20, and the amount of relative displacements, using storages, such as a floppy disk. And when two or more solid images are piled up and image equalization processing is performed in case synthetic processing of image data is performed by this solid image processor 32 in order to make higher precision of the solid image compounded by said solid image processor 32, a highly precise solid image will be obtained.
[0030] Drawing 3 is the block diagram having shown the control circuit Fig. of the micro capacity type acceleration detector (only henceforth an "acceleration detector") with which the three-dimensions displacement gage 26 shown in said drawing 1 is equipped, and which is not illustrated. The direction of an arrow head shown all over drawing shows the direction where a signal is outputted. Moreover, the timing chart of the signal in each control circuit shown in this drawing 3 is shown in drawing 4 . The acceleration sensor 51 which measures the movement magnitude (variation rate amount) of the moire camera 20 in the photography image data which

had and photoed said moire camera 20 is formed, and this acceleration detector 50 is connected with a transmitter 52, reference voltage 53, and an integrator 54.
[0031] Moreover, it connects with a synchronous circuit 55 and said transmitter 52 is connected to an integrator 54 through the hold reset circuit 56. In addition, a thermometric element 57 is connected to this integrator 54, and when predetermined temperature is detected, an output signal is transmitted to an integrator 54.
[0032] Said acceleration sensor 51 and reference voltage 53, and the integrator 54 that received the signal from the thermometric element 57 in the hold reset circuit 56 list carry out control processing of these data, and outputs said processed data to A/D (A/D converter)62 through a switcher 60. And an output signal is changed into an analog or a digital signal with A/D converter 62. The signal changed here will be outputted to a microprocessor 61, and A/D converter 62 will obtain the output from a microprocessor 61.
[0033] Whenever said microprocessor 61 receives the sampling from A/D converter 62, it calculates the average of the value in a past fixed period, or the average to which the nearer past applied weight. It is high responsibility by this, and highly precise acceleration will be obtained. And if the output of a hold circuit 56 and a reset circuit 56, and an integrator 54 is inserted in juxtaposition to the output of an acceleration sensor 51 as shown in drawing 4 (integral value of the part of positive logic), - (integral value of part of negative logic) speed of response will become twice, the speed of response of said three-dimensions displacement gage 26 improves, and response engine performance's shutter timing measurement and shutter actuation of a digital camera 24 which were mentioned already improve.
[0034] Drawing 5 shows the actuation in the moire camera 20 shown in said drawing 1 and drawing 2 with the block diagram. If a photograph is taken as it is also with the moire camera 20 about said device under test 12 as mentioned already, the shutter timing and shutter actuation will be performed automatically, and two or more photography image data (for example, the photography image data 1, photography image data 2 ..) will be obtained. And as mentioned already, the amount of relative displacements in a device under test 12 is computed from these two or more photography image data.
[0035] The space-coordinates point of three dimensions is computed for every pixel [in / in each of two or more of said photography image data (the photography image data 1, photography image data 2 ..) / the photography image data (the photography image data 1, photography image data 2 ..)]. And as shown in drawing 6 , each photography image data (the photography image data 1, photography image data 2 ..) is complemented based on said computed amount of relative displacements. Two or more of these complemented photography image data (the photography image data 1, photography image data 2 ..) and said amount of relative displacements will be serially sent to a dedicated purpose computer 30.
[0036] Drawing 7 shows the actuation in the dedicated purpose computer 30 shown in said drawing 2 with the block diagram. As shown in said drawing 5 , two or more complemented photography image data (the photography image data 1, photography image data 2 ..) is serially incorporated by the dedicated purpose computer 30 for every photography image data of the. And the part which has shape facilities, such as irregularity, to the direction of a normal of an image for every photography image data of this is extracted, the successive approximation of the space-coordinates point of said three dimensions is carried out, and a focus group is extracted. Furthermore, by processing the curvature distribution which can be set at least to the pars convoluta lobuli corticalis renis of each photography image data using technique, such as a hash method and a Monte Carlo method, a focus group is classified and curvature approximates a small part with a polyhedron or a free sculptured surface.
[0037] And as mentioned already, in the description configuration of said photography image data, an operator chooses and extracts circular and the part which has known configurations, such as the shape of a cylindrical shape. However, since the extract of this known configuration is automatically extracted by the dedicated purpose computer 30 in flat surfaces, such as a straight line, the selection extract by the operator is not needed. Moreover, since individual difference is in the criteria of the distinction to the configuration when an operator performs the selection extract of the shape of this round shape and a cylindrical shape etc., the time amount

which the time amount which the extract takes, and future processings take is not uniform.
[0038] For example, if the case where the multiple-selection extract of the shape of the case where the selection extract of the shape of a round shape or a cylindrical shape is not carried out at all, a circle configuration, and a cylindrical shape is carried out in the same photography image data is compared Since the direction at the time of carrying out the selection extract of two or more the shape of a circle configuration and a cylindrical shape converges early the convergence count for displaying the solid image mentioned later, the direction when the solid image of three dimensions carries out the multiple-selection extract of the shape of a circle configuration and a cylindrical shape will be obtained early.
[0039] Moreover, as mentioned already, the selection extract of the known configuration part in each photography image data (the photography image data 1, photography image data 2 ..) is good to carry out the selection extract of the precision nibble set up in said device under test 12. The part which designs this device under test 12 with precision in the time of the manufacture beforehand is set up. Since the configuration data of a device under test 12 show beforehand the part which has this precision, by using this precision nibble for the selection extract of the part of a known configuration, it will be certainly completed by the convergence count mentioned later, and a highly precise solid image will be obtained.
[0040] And in consideration of "weight" value, the amount of error hopes which is the range of the error in a this "weight" value further is obtained from the precision of said extracted shape facility and a known configuration, and it evaluates using a performance index. In addition, since a this "weight" value changes with classes, such as a configuration of a device under test 12, and the quality of the material, it will be set up according to a device under test 12.
[0041] Furthermore, equalization processing of said shape facility and known configuration which were extracted is carried out using count of the least square method etc. within the limits of said amount of error hopes. And the location of this shape facility and a known configuration calculates the amount of displacement which is best in agreement, and convergence count is performed so that the value of said performance index may become min by making this amount of displacement into initial value. and said shape facility and known configuration which are included in each photography image data (the photography image data 1, photography image data 2 ..) as shown in drawing 8 — piling up — each — photography image data (photography image data 1, photography image data 2 ..) composition will be carried out.
[0042] Drawing 9 is the flow chart which showed the actuation in this three dimensional image gaging system 10. It checks whether in photography of a device under test 12, it has first a configuration which turns into the configuration with the description. Although pasting of a target 40 is not needed when it has irregularity and a part which serves as the description in addition to this (S10 "YES") When it does not have the part used as said description (S10 "NO"), on the front face of a device under test 12, two or more predetermined targets 40 are stuck (S12), and it uses as a description configuration of a device under test 12.
[0043] Moreover, when said device under test 12 is the movable body which is carrying out movable also at the time of photography (S14 "NO"), a three-dimensions displacement gage is attached also on this device under test 12 (S16). However, if it is the halt body which said device under test 12 has suspended (S14 "YES"), it is not necessary to attach this three-dimensions displacement gage.
[0044] Furthermore, it inputs that it is also at dialogic operation about data, such as a near distance of said moire camera 20 and device under test 12, and a pixel consistency, (S18), and a photograph is taken, shifting so that a device under test 12 may be overlapped as it is also with the moire camera 20 (S20). If photography of a device under test 12 is started with this moire camera 20 as mentioned already, a fringe (moire pattern) will be floodlighted on this device under test 12 from the projector 22 formed in the moire camera 20, a photograph will be taken as the CCD digital camera 24 is also about this fringe, and photography image data will be obtained.
[0045] In addition, timing measurement which cuts the shutter of the CCD digital camera 24, and shutter actuation are automatically performed according to the amount of relative displacements computed by the three-dimensions displacement gage 26 formed in said moire camera 20, as mentioned already in said drawing 2 . Data will be complemented for that each every image data

of photography, and two or more photography image data photoed by this will be serially sent to a dedicated purpose computer 30 with this amount of relative displacements, as shown in said drawing 5 (S22).
[0046] And two or more photography image data sent to said dedicated purpose computer 30 carries out equalization processing (S24) of each while carrying out the selection extract of the shape facility part and known configuration of a device under test 12 in that each image data of photography, as shown in said drawing 7 . And after piling up and compounding said every one photography image data by the solid image processor 32 so that the extracted this description part and the part of a known configuration may be most in agreement (S26), the solid image of three dimensions will be again displayed on a dedicated purpose computer 30 on the screen of delivery and this dedicated purpose computer 30.
[0047] Thus, if the approximate value acquired from two or more photography image data by carrying out the selection extract of the known configurations of having the description configuration in a device under test, such as a part and a circle configuration, and carrying out the mean square of the error in these directions of a normal further is in a predetermined error range, a highly precise solid image will be obtained. That is, since adjustment of the solid image which piles up and obtains said photography image is also good when the description configuration and known configuration which carried out the selection extract from said photography image data are adjusted, as a result, a highly precise solid image will be obtained.
[0048] Moreover, although not illustrated, it is also possible to use for data processing of the photography image data in this example the three dimensional image measuring device which used Space FFT. Space FFT is used for this processing, although the three dimensional image measuring device using this space FFT photos a device under test using a commercial digital camcorder etc., and incorporates and carries out data processing of that photography image data to a computer using storages, such as a floppy disk and RAM, and the solid image of three dimensions is obtained.
[0049] Processing of the photography image data based on said space FFT obtains highly precise image display by enabling the detailed outside profile extract of a device under test, and carrying out voxel processing of this photography image data downloaded to the computer further. In addition to the shade information acquired from the conventional photography image data, by this, a highly precise solid image will be obtained from acquiring the information on the space-coordinates location in three dimensions.
[0050] Alterations various in the range which is not limited to the above-mentioned example at all, and does not deviate from the meaning of this invention are possible for this invention. For example, although the moire camera was used in this example, at any time is possible for the modification addition of the synthetic approach of the extract approach of the description part by the approach and photography image data which download the photography image data of the device under test which a camera, a peripheral device, etc. to be used were not limited, and was photoed to a computer, and a known configuration, the known configuration to extract, and also a solid image, the method of presentation of the completed solid image, etc.
[0051]
[Effect of the Invention] As explained above, according to invention according to claim 1, efficient photography can be carried out, without choosing a device under test by using a portable digital camcorder, since photography becomes possible, without [still more nearly movable or] asking conditions, such as a halt, etc., the configuration of a device under test, magnitude, and. And the data with the highly precise possible photography image data in a required process by the time each photography image data will have high degree of accuracy and carries out the three dimentional display of this photography image data by complementing the photography image data which photoed and obtained this device under test are obtained. Therefore, a highly precise three-dimensions solid image will be obtained.
[0052] And while computing the amount of relative displacements of a video camera and a device under test and using for complement processing of photography image data like invention according to claim 2 Furthermore, if the selection extract of the description configuration and known configuration in photography image data is carried out and each photography image data

is adjusted like invention according to claim 3 based on this amount of relative displacements It becomes possible to aim at compaction of the duration which the convergence count in each photography image data becomes easy to converge, and data processing takes to this, and even if it does not take experience of an operator etc. into consideration further, a solid image with the high dependability equipped with fixed precision will be obtained easily.

[0053] Furthermore, still like invention according to claim 5, when there is no description in the configuration of a device under test, while preparing an auxiliary member on the front face like invention according to claim 4, when a device under test is a movable body, it is good to attach a three-dimensions displacement pickup on the front face of a device under test. Accurate photography image data is obtained without choosing a device under test by this. And since it is not necessary to take into consideration a configuration, a condition, etc. of a device under test in this way again, the application will also spread.

[0054] Moreover, it becomes possible like invention according to claim 6 to obtain a clear solid image by processing the photography image data of a device under test using Space FFT. In addition, while a commercial video camera is used for the camera used in the case of this photography, since the migration which uses storages, such as a commercial floppy disk and RAM, is possible, migration of data and the general purpose by it are easy also for this, and it is efficient. [of the photography image data obtained by this]

[0055] And the solid image created in this way can also make an operation navigation system, a simulation system, etc. using the photography image data which photos and obtains a road, a building, etc. while solid CG data are created and it can make animation, virtual reality (virtual reality), etc. by using the image information which added the color picture to said photography image data. Furthermore, since it is possible to make verification, a game, etc. of assembly nature in a machinery, a product, etc., it can respond to the application broadly.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] In case this invention piles up in more detail two or more photography image data which photoed and obtained the device under test about a digital three-dimensions gaging system and gives a synthetic indication of the solid image, it relates to the digital three dimensional image gaging system which can display a highly precise solid image for a short time by carrying out data processing of this photography image data.

[Translation done.]

PRIOR ART

[Description of the Prior Art] A CCD camera etc. is used in order to photo the device under test which has a 2-dimensional configuration or a three-dimensions configuration, to numerical-model-ize the photography image, or to display it as a solid image on screens, such as a computer, conventionally, and to raise the precision of the photography image data. The method of presentation of the solid image of a device under test using this CCD camera installs this device under test in the measuring point set up beforehand, and photos this device under test from two places while it installs this CCD camera in the pointing device which was able to be formed beforehand first. While obtaining two or more measure points for the pars convoluta lobuli corticalis renis of a device under test, the curvature for this pars convoluta lobuli corticalis renis is calculated, this photography image data that carried out computation is compounded, and the numerical model and solid image of this device under test are obtained from each of two or more photography image data obtained by this photography.
[0003] Moreover, there is a thing using an optical approach besides said approach. By this approach, after sticking two or more predetermined auxiliary objects on the front face of this device under test, light is irradiated to up to this device under test using the light source. While the reflected light arises on this device under test by this optical exposure, the light and shadow by this auxiliary object will arise, and a photograph is taken as it is also with a CCD camera about this. And detection processing is carried out to it being also with a digital image sensor about two or more photography image data obtained by this photography, two or more of these photography image data that carried out detection processing is compounded, and a solid image is obtained.

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EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, according to invention according to claim 1, efficient photography can be carried out, without choosing a device under test by using a portable digital camcorder, since photography becomes possible, without [still more nearly movable or] asking conditions, such as a halt, etc., the configuration of a device under test, magnitude, and. And the data with the highly precise possible photography image data in a required process by the time each photography image data will have high degree of accuracy and carries out the three dimentional display of this photography image data by complementing the photography image data which photoed and obtained this device under test are obtained. Therefore, a highly precise three-dimensions solid image will be obtained.
[0052] And while computing the amount of relative displacements of a video camera and a device under test and using for complement processing of photography image data like invention according to claim 2 Furthermore, if the selection extract of the description configuration and known configuration in photography image data is carried out and each photography image data is adjusted like invention according to claim 3 based on this amount of relative displacements It becomes possible to aim at compaction of the duration which the convergence count in each photography image data becomes easy to converge, and data processing takes to this, and even if it does not take experience of an operator etc. into consideration further, a solid image with the high dependability equipped with fixed precision will be obtained easily.
[0053] Furthermore, still like invention according to claim 5, when there is no description in the configuration of a device under test, while preparing an auxiliary member on the front face like invention according to claim 4, when a device under test is a movable body, it is good to attach a three-dimensions displacement pickup on the front face of a device under test. Accurate photography image data is obtained without choosing a device under test by this. And since it is not necessary to take into consideration a configuration, a condition, etc. of a device under test in this way again, the application will also spread.
[0054] Moreover, it becomes possible like invention according to claim 6 to obtain a clear solid image by processing the photography image data of a device under test using Space FFT. In addition, while a commercial video camera is used for the camera used in the case of this photography, since the migration which uses storages, such as a commercial floppy disk and RAM, is possible, migration of data and the general purpose by it are easy also for this, and it is efficient. [of the photography image data obtained by this]
[0055] And the solid image created in this way can also make an operation navigation system, a simulation system, etc. using the photography image data which photos and obtains a road, a building, etc. while solid CG data are created and it can make animation, virtual reality (virtual reality), etc. by using the image information which added the color picture to said photography image data. Furthermore, since it is possible to make verification, a game, etc. of assembly nature in a machinery, a product, etc., it can respond to the application broadly.

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* NOTICES *

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, time amount is taken [after the pointing device which installs this CCD camera is expensive, or installing a CCD camera in a pointing device in the approach of installing a CCD camera in the pointing device formed beforehand, and obtaining the solid image of a device under test since the configuration is large-scale as described above] to start photography. Moreover, since unreasonableness arose in photography if a device under test is not much large, since carrying of a CCD camera is difficult, there was a problem that the magnitude and the configuration of a device under test will be restricted.
[0005] In addition, in order to compute the curvature for the pars convoluta lobuli corticalis renis of a device under test from the photography image data which photoed and obtained said device under test, since the precision of the photography image data influences greatly, it is difficult to compute accurate curvature, and the calculation takes time amount further. Moreover, there was a problem that dispersion appeared in the precision of the computed curvature and the precision of a solid image, and dependability was missing from how taking [number / the measure point location for the pars convoluta lobuli corticalis renis of the device under test used for calculation of this curvature, / of the measure point] influencing calculation of said curvature greatly.
[0006] Furthermore, in the above mentioned optical approach, since a predetermined auxiliary object must be stuck on a device under test, time and effort is required, and by the time this also starts photography, it will require time amount. And since that pasting location influences the precision of a solid image greatly in case this auxiliary object is stuck on a device under test, as described above also in this approach, dispersion will appear in precision and dependability will be missing. moreover, it is difficult to be easy to produce an optical interference in the light used as the light source, in case an optical exposure is performed on the front face of a device under test and that light and shadow are acquired, and to make the effect by this optical interference mitigate — etc. — there was a problem.
[0007] Then, in obtaining the solid image of the device under test which has solid configurations, such as a 2-dimensional configuration or a three-dimensions configuration, the technical problem which this invention tends to solve is offering the digital three dimensional image gaging system which the precision's is raised and can obtain a highly precise solid image.

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MEANS

[Means for Solving the Problem] In order to solve this technical problem, the digital three dimensional image gaging system of this invention The portable digital camcorder which photos a device under test, In a digital three dimensional image gaging system equipped with the processing unit which carries out data processing of the photography image data of this device under test photoed with this digital camcorder, and the three dimentional display image [three dimensional image] processor based on this photography image data that carried out data processing A photography image acquisition means to photo a device under test and to obtain two or more photography image data with this digital camcorder, The image data data-processing means which incorporates and carries out data processing of two or more image data obtained with this photography image data acquisition means to this processing unit, Let it be a summary to have a solid image creation display means to display the solid image which compounded and created each photography image data processed with this data-processing means.
[0009] According to invention of the above-mentioned publication, it has a three dimentional display image [three dimensional image] processor based on the photography image data by which this data processing was carried out to the processing unit which carries out data processing of the photography image data of this device under test to the digital camcorder which is a digital type and can be carried. While obtaining two or more photography image data with the photography image acquisition means by this digital camcorder Data processing of two or more photography image data obtained by this is carried out with the image data data-processing means by this processing unit, this photography image data is further compounded for this with a solid image creation display means, and a solid image is displayed. It becomes possible to be high degree of accuracy and to obtain the solid image of a device under test by this, for a short time, since data processing is possible for a short time while becoming possible to obtain photography image data with a sufficient precision.
[0010] And at this time, it is good to compute the movement magnitude between photography image data with a photography image data movement magnitude calculation means based on the detection value equipped with the three-dimensions displacement gage which becomes a digital camcorder from a three-dimensions displacement pickup, a three-dimensions include-angle detector, and a three-dimensions acceleration detector like invention according to claim 2 both according to these detectors, and to calculate the amount of relative displacements between this digital camcorder and a device under test from this movement magnitude further. Accurate photography image data will be obtained by this and a highly precise solid image will be obtained.
[0011] Furthermore, like invention according to claim 3, in each of two or more of said photography image data, the description configuration of a device under test is extracted with the description configuration extract means, and known configurations, such as the shape of a circle configuration or a square, are further extracted with a known configuration extract means. And it is good to create the three dimensional image of a device under test with superposition, this piled-up photography image data, and said amount of relative displacements for the same parts of this extracted description configuration and a known configuration with a photography image data adjustment means. A solid image with adjustment of two or more image data effectively highly precise from the ability to also carry out ** with a sufficient precision will be

obtained by this.
[0012] And when it is the movable body In which attaches two or more auxiliary members on the front face of this device under test, and makes the shape facility of a device under test, and said device under test is carrying out movable like invention according to claim 5 when there is no part from which the shape of surface type of said device under test turns into the description configurations, such as irregularity, at a flat surface like Invention according to claim 4, it is good to attach and photo a three-dimensions displacement pickup on the front face of a device under test. Photography becomes possible, without choosing the configuration of a device under test, and the situation of a halt or movable ** by this, and it is efficient. Moreover, since the photography image data obtained by photography is also highly precise, a solid image highly precise as a result is obtained.
[0013] Moreover, the portable digital camcorder with which invention according to claim 6 photos a device under test, In a digital three dimensional image gaging system equipped with the processing unit which carries out data processing of the photography image data of this device under test photoed with this digital camcorder, and the three dimentional display image [three dimensional image] processor based on this photography image data that carried out data processing A photography image acquisition means to photo a device under test and to obtain two or more photography image data with this digital camcorder, A photography image data data-processing means to process using Space FFT for this data processing while incorporating and carrying out data processing of two or more image data obtained with this photography image data acquisition means to this processing unit, Let it be a summary to have a solid image creation display means to display the solid image which compounded and created each photography image data processed with this photography image data data-processing means.
[0014] According to invention of the above-mentioned publication, it has a three dimentional display image [three dimensional image] processor based on the photography image data by which this data processing was carried out to the processing unit which carries out data processing of the photography image data of this device under test to the digital camcorder which is a digital type and can be carried. While obtaining two or more photography image data with the photography image acquisition means by this digital camcorder Data processing of two or more photography image data obtained by this is carried out with the image data data-processing means by the space FFT of this processing unit, this photography image data is further compounded for this with a solid image creation display means, and a solid image is displayed. Since data processing is possible for a short time while this enables it to obtain photography image data with a sufficient precision, it becomes possible to obtain the solid image of a device under test in the much more high degree of accuracy and the much more short time.
[0015]
[Embodiment of the Invention] The gestalt of suitable 1 operation of this invention is hereafter taken for an example, and it explains to a detail with reference to a drawing. In addition, a moire camera shall be used for the digital-type video camera which photos a device under test in this example, and a device under test presupposes that it is the halt object which does not carry out movable. Drawing 1 shows the block diagram of the digital three dimensional image gaging system concerning the gestalt of 1 operation of this invention. This digital three dimensional image gaging system 10 is constituted by the moire camera 20 which divides roughly, photos a device under test 12, and obtains that photography image data, and the dedicated purpose computer 30 which processes that photography image data.
[0016] The three-dimensions displacement gage 26 for said moire camera 20 to compute the amount of relative displacements of MOAKAMERA 20 in the CCD digital camera 24 and this device under test 12 of the industrial use way which photos the projector 22 which irradiates the fringe (moire pattern) which is a grid pattern by shading of light on a device under test 12 at the interior, and the this irradiated fringe is formed. In addition, it is constituted that the specification is also with a wired system with the precision of **0.1mm of photographic coverage 200mmx160mm and a solid image, a resolution [6/100], and a weight of 1.5kg.
[0017] Said projector 22 has glass with which said fringe (moire pattern) was prepared in the lens of the light source for performing that optical exposure, and this fringe is floodlighted on a

device under test 12 by performing an optical exposure through this glass. And the condition of this fringe will be photoed by photoing a device under test 12 as said CCD digital camera 24 is also.

[0018] Moreover, said three-dimensions displacement gage 26 is constituted by the three-dimensions displacement pickup and three-dimensions include-angle detector which are not illustrated, and the three-dimensions acceleration detector. And a photograph is taken shifting little by little that the CCD digital camera 24 in which the device under test 12 which projected said fringe was formed by said moire camera 20 is also, and the movement magnitude (variation rate amount) of this moire camera 20 is computed with the same part of the device under test 12 in the photography image data. While calculating automatically the optimal timing for cutting the shutter in this CCD digital camera 24 based on this amount of displacement, continuous shutter actuation is performed automatically. In addition, this three-dimensions displacement gage 26 consists of wired systems with a% [of precision] of 3, and a weight of 300g.

[0019] Moreover, while said dedicated purpose computer 30 carries out data processing of the photography image data photoed with said moire camera 20, the image processor 32 which carries out synthetic processing of this photography image data that carried out data processing, and displays the solid image of three dimensions is formed. This moire camera 20 and this dedicated purpose computer 30 are incorporated serially automatically by connecting with the wired system to a dedicated purpose computer 30, and data processing of the photography image data of two or more device under tests 12 photoed with this moire camera 20 is carried out by this, and it is constituted so that it may be compounded in this solid image processor 32 after that.

[0020] In addition, also in case a photograph is taken as said device under test 12 is also with said moire camera 20, when it is the movable body which is moving, said three-dimensions displacement gage 26 and the same three-dimensions displacement gage which is not illustrated are attached on the front face of a device under test 12. And when the main ****** description has the configuration of said device under test 12 neither at a flat-surface configuration nor flatness, it is good to take a photograph with the same approach with having stuck two or more targets 40 which consisted of predetermined two-dimensional configurations or solid configurations as an auxiliary member of the configuration of a device under test 12 on the front face of this device under test 12, and having described this above again.

[0021] Drawing 2 shows the configuration of the digital three dimensional image gaging system 10 shown in said drawing 1 with the block diagram. In addition, the direction of an arrow head in drawing shows the I/O direction of data. The moire camera 20 is constituted by a projector 22, the CCD digital camera (digital camera) 24, and the three-dimensions displacement gage 26 so that it may illustrate. And as mentioned already, a photograph will be taken as a digital camera 24 is also about the fringe (moire pattern) floodlighted on the device under test 12 by the projector 22 formed in said moire camera 20, and data processing will be carried out to it being also with the software for analysis in which this photoed fringe was prepared by this moire camera 20 and which is not illustrated.

[0022] In addition, in case a device under test 12 is photoed as it is also with said moire camera 20, a near distance of the camera station of this moire camera 20 and the installation location of a device under test 12 is given beforehand. And it is good to take a photograph, moving so that the photography part of this device under test 12 may be overlapped as it is also with this moire camera 20.

[0023] And as are described above, and it overlaps, the amount of relative displacements in a device under test 12 is computed from include-angle change computed based on the migration length and this photography image data which the moire camera 20 moved from two or more photoed photography image data. The timing which cuts the shutter of the CCD digital camera 24 based on this computed amount of relative displacements is measured, and a shutter is cut. In addition, all of measurement and shutter actuation of the timing which cuts these these shutters are performed automatically. While shutter timing is efficiently measurable with this, it becomes possible [the photography number of sheets] to press down to the minimum.

[0024] After said amount of relative displacements and the photography image data

automatically photoed with said moire camera 20 are complemented in order to improve the detection precision of the space-coordinates location in this photography image, whenever 1 photography image data is obtained by the shutter actuation, it is serially sent to a dedicated purpose computer 30. However, it is constituted so that an operator may input that data, such as a voxel consistency in this case, are also at an interactive format.
[0025] And the part which has a characteristic configuration in the direction of a normal of photography image data [in / that it is also with the software 35 in said dedicated purpose computer 30 / said device under test 12] is extracted for every previous 1 photography image data. The extract of this description part extracts flat-surface configurations, such as the shape of music flat surfaces which are the projection parts in the configuration of a device under test 12 etc., such as an others and circle configuration, the shape of a cylinder and also a square, or a triangle, and the so-called known configuration.
[0026] However, although flat-surface configurations, such as the shape of the shape of a square or a triangle, are automatically extracted in the case of the feature extraction of said known configuration, an operator will do the selection extract of the so-called circle configurations, such as the shape of a polar plane or a cylindrical shape. In addition, although whenever [recognition / of whenever / distinction / of the circle configuration at the time of this feature extraction / the number to extract] changes with operators, by the time a solid image is finally obtained by some, its extract part, number of the circle configuration by which the selection extract was carried out here, etc., some time difference will arise by them.
[0027] And in each photography image data by which said extracted known configuration is photoed, equalization processing of the same known configuration is carried out using count of the least square method etc., and this known configuration calculates the amount of displacement most in agreement. While having this every one photography image data and piling up and compounding it on the solid image processor 32 based on the amount of displacement computed here, the solid image of three dimensions will be again displayed for this compound image on a dedicated purpose computer 30 on the screen of delivery and this dedicated purpose computer 30.
[0028] In addition, it is good to check whether it has the description which the configuration of this device under test 12 mentioned already on the occasion, for the configuration of this device under test 12 to stick two or more targets 40 on the front face of a device under test 12, when the description is not seen in a flat surface and a flat configuration, and to use for photography of said device under test 12 as a shape facility. Moreover, when this device under test 12 is a movable body, as mentioned already, a three-dimensions displacement gage is attached on a device under test 12. However, when the device under test 12 has stopped, this three-dimensions displacement gage may be omitted, without attaching.
[0029] Moreover, you may make it deliver and receive transfer of data, such as photography image data photoed with said moire camera 20, and the amount of relative displacements, using storages, such as a floppy disk. And when two or more solid images are piled up and image equalization processing is performed in case synthetic processing of image data is performed by this solid image processor 32 in order to make higher precision of the solid image compounded by said solid image processor 32, a highly precise solid image will be obtained.
[0030] Drawing 3 is the block diagram having shown the control circuit Fig. of the micro capacity type acceleration detector (only henceforth an "acceleration detector") with which the three-dimensions displacement gage 26 shown in said drawing 1 is equipped, and which is not illustrated. The direction of an arrow head shown all over drawing shows the direction where a signal is outputted. Moreover, the timing chart of the signal in each control circuit shown in this drawing 3 is shown in drawing 4 . The acceleration sensor 51 which measures the movement magnitude (variation rate amount) of the moire camera 20 in the photography image data which had and photoed said moire camera 20 is formed, and this acceleration detector 50 is connected with a transmitter 52, reference voltage 53, and an integrator 54.
[0031] Moreover, it connects with a synchronous circuit 55 and said transmitter 52 is connected to an integrator 54 through the hold reset circuit 56. In addition, a thermometric element 57 is connected to this integrator 54, and when predetermined temperature is detected, an output

signal is transmitted to an integrator 54.
[0032] Said acceleration sensor 51 and reference voltage 53, and the integrator 54 that received the signal from the thermometric element 57 in the hold reset circuit 56 list carry out control processing of these data, and outputs said processed data to A/D (A/D converter)62 through a switcher 60. And an output signal is changed into an analog or a digital signal with A/D converter 62. The signal changed here will be outputted to a microprocessor 61, and A/D converter 62 will obtain the output from a microprocessor 61.
[0033] Whenever said microprocessor 61 receives the sampling from A/D converter 62, it calculates the average of the value in a past fixed period, or the average to which the nearer past applied weight. It is high responsibility by this, and highly precise acceleration will be obtained. And if the output of a hold circuit 56 and a reset circuit 56, and an integrator 54 is inserted in juxtaposition to the output of an acceleration sensor 51 as shown in drawing 4 (integral value of the part of positive logic), - (integral value of part of negative logic) speed of response will become twice, the speed of response of said three-dimensions displacement gage 26 improves, and response engine performance's shutter timing measurement and shutter actuation of a digital camera 24 which were mentioned already improve.
[0034] Drawing 5 shows the actuation in the moire camera 20 shown in said drawing 1 and drawing 2 with the block diagram. If a photograph is taken as it is also with the moire camera 20 about said device under test 12 as mentioned already, the shutter timing and shutter actuation will be performed automatically, and two or more photography image data (for example, the photography image data 1, photography image data 2 ..) will be obtained. And as mentioned already, the amount of relative displacements in a device under test 12 is computed from these two or more photography image data.
[0035] The space-coordinates point of three dimensions is computed for every pixel [in / in each of two or more of said photography image data (the photography image data 1, photography image data 2 ..) / the photography image data (the photography image data 1, photography image data 2 ..)]. And as shown in drawing 6 , each photography image data (the photography image data 1, photography image data 2 ..) is complemented based on said computed amount of relative displacements. Two or more of these complemented photography image data (the photography image data 1, photography image data 2 ..) and said amount of relative displacements will be serially sent to a dedicated purpose computer 30.
[0036] Drawing 7 shows the actuation in the dedicated purpose computer 30 shown in said drawing 2 with the block diagram. As shown in said drawing 5 , two or more complemented photography image data (the photography image data 1, photography image data 2 ..) is serially incorporated by the dedicated purpose computer 30 for every photography image data of the. And the part which has shape facilities, such as irregularity, to the direction of a normal of an image for every photography image data of this is extracted, the successive approximation of the space-coordinates point of said three dimensions is carried out, and a focus group is extracted. Furthermore, by processing the curvature distribution which can be set at least to the pars convoluta lobuli cortioalis renis of each photography image data using technique, such as a hash method and a Monte Carlo method, a focus group is classified and curvature approximates a small part with a polyhedron or a free sculptured surface.
[0037] And as mentioned already, in the description configuration of said photography image data, an operator chooses and extracts circular and the part which has known configurations, such as the shape of a cylindrical shape. However, since the extract of this known configuration is automatically extracted by the dedicated purpose computer 30 in flat surfaces, such as a straight line, the selection extract by the operator is not needed. Moreover, since individual difference is in the criteria of the distinction to the configuration when an operator performs the selection extract of the shape of this round shape and a cylindrical shape etc., the time amount which the time amount which the extract takes, and future processings take is not uniform.
[0038] For example, if the case where the multiple-selection extract of the shape of the case where the selection extract of the shape of a round shape or a cylindrical shape is not carried out at all, a circle configuration, and a cylindrical shape is carried out in the same photography image data is compared Since the direction at the time of carrying out the selection extract of

two or more the shape of a circle configuration and a cylindrical shape converges early the convergence count for displaying the solid image mentioned later, the direction when the solid image of three dimensions carries out the multiple-selection extract of the shape of a circle configuration and a cylindrical shape will be obtained early.

[0039] Moreover, as mentioned already, the selection extract of the known configuration part in each photography image data (the photography image data 1, photography image data 2 ..) is good to carry out the selection extract of the precision nibble set up in said device under test 12. The part which designs this device under test 12 with precision in the time of the manufacture beforehand is set up. Since the configuration data of a device under test 12 show beforehand the part which has this precision, by using this precision nibble for the selection extract of the part of a known configuration, it will be certainly completed by the convergence count mentioned later, and a highly precise solid image will be obtained.

[0040] And in consideration of "weight" value, the amount of error hopes which is the range of the error in a this "weight" value further is obtained from the precision of said extracted shape facility and a known configuration, and it evaluates using a performance index. In addition, since a this "weight" value changes with classes, such as a configuration of a device under test 12, and the quality of the material, it will be set up according to a device under test 12.

[0041] Furthermore, equalization processing of said shape facility and known configuration which were extracted is carried out using count of the least square method etc. within the limits of said amount of error hopes. And the location of this shape facility and a known configuration calculates the amount of displacement which is best in agreement, and convergence count is performed so that the value of said performance index may become min by making this amount of displacement into initial value, and said shape facility and known configuration which are included in each photography image data (the photography image data 1, photography image data 2 ..) as shown in drawing 8 -- piling up — each — photography image data (photography image data 1, photography image data 2 ..) composition will be carried out.

[0042] Drawing 9 is the flow chart which showed the actuation in this three dimensional image gaging system 10. It checks whether in photography of a device under test 12, it has first a configuration which turns into the configuration with the description. Although pasting of a target 40 is not needed when it has irregularity and a part which serves as the description in addition to this (S10 "YES") When it does not have the part used as said description (S10 "NO"), on the front face of a device under test 12, two or more predetermined targets 40 are stuck (S12), and it uses as a description configuration of a device under test 12.

[0043] Moreover, when said device under test 12 is the movable body which is carrying out movable also at the time of photography (S14 "NO"), a three-dimensions displacement gage is attached also on this device under test 12 (S16). However, if it is the halt body which said device under test 12 has suspended (S14 "YES"), it is not necessary to attach this three-dimensions displacement gage.

[0044] Furthermore, it inputs that it is also at dialogic operation about data, such as a near distance of said moire camera 20 and device under test 12, and a pixel consistency, (S18), and a photograph is taken, shifting so that a device under test 12 may be overlapped as it is also with the moire camera 20 (S20). If photography of a device under test 12 is started with this moire camera 20 as mentioned already, a fringe (moire pattern) will be floodlighted on this device under test 12 from the projector 22 formed in the moire camera 20, a photograph will be taken as the CCD digital camera 24 is also about this fringe, and photography image data will be obtained.

[0045] In addition, timing measurement which cuts the shutter of the CCD digital camera 24, and shutter actuation are automatically performed according to the amount of relative displacements computed by the three-dimensions displacement gage 26 formed in said moire camera 20, as mentioned already in said drawing 2 . Data will be complemented for that each every image data of photography, and two or more photography image data photoed by this will be serially sent to a dedicated purpose computer 30 with this amount of relative displacements, as shown in said drawing 5 (S22).

[0046] And two or more photography image data sent to said dedicated purpose computer 30 carries out equalization processing (S24) of each while carrying out the selection extract of the

shape facility part and known configuration of a device under test 12 in that each image data of photography, as shown in said drawing 7 . And after piling up and compounding said every one photography image data by the solid image processor 32 so that the extracted this description part and the part of a known configuration may be most in agreement (S26), the solid image of three dimensions will be again displayed on a dedicated purpose computer 30 on the screen of delivery and this dedicated purpose computer 30.

[0047] Thus, if the approximate value acquired from two or more photography image data by carrying out the selection extract of the known configurations of having the description configuration in a device under test, such as a part and a circle configuration, and carrying out the mean square of the error in these directions of a normal further is in a predetermined error range, a highly precise solid image will be obtained. That is, since adjustment of the solid image which piles up and obtains said photography image is also good when the description configuration and known configuration which carried out the selection extract from said photography image data are adjusted, as a result, a highly precise solid image will be obtained.

[0048] Moreover, although not illustrated, it is also possible to use for data processing of the photography image data in this example the three dimensional image measuring device which used Space FFT. Space FFT is used for this processing, although the three dimensional image measuring device using this space FFT photos a device under test using a commercial digital camcorder etc., and incorporates and carries out data processing of that photography image data to a computer using storages, such as a floppy disk and RAM, and the solid image of three dimensions is obtained.

[0049] Processing of the photography image data based on said space FFT obtains highly precise image display by enabling the detailed outside profile extract of a device under test, and carrying out voxel processing of this photography image data downloaded to the computer further. In addition to the shade information acquired from the conventional photography image data, by this, a highly precise solid image will be obtained from acquiring the information on the space-coordinates location in three dimensions.

[0050] Alterations various in the range which is not limited to the above-mentioned example at all, and does not deviate from the meaning of this invention are possible for this invention. For example, although the moire camera was used in this example, at any time is possible for the modification addition of the synthetic approach of the extract approach of the description part by the approach and photography image data which download the photography image data of the device under test which a camera, a peripheral device, etc. to be used were not limited, and was photoed to a computer, and a known configuration, the known configuration to extract, and also a solid image, the method of presentation of the completed solid image, etc.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the digital three dimensional image gaging system concerning the operation gestalt of this invention.
[Drawing 2] It is the block diagram having shown the configuration of the digital three dimensional image gaging system shown in drawing 1 .
[Drawing 3] It is the block diagram having shown the control circuit Fig. of the micro capacity type acceleration detector with which the three-dimensions displacement gage shown in drawing 1 is equipped.
[Drawing 4] It is the timing chart which showed the signal in each control circuit shown in drawing 3 .
[Drawing 5] It is the block diagram having shown actuation of a moire camera.
[Drawing 6] It is drawing having shown the complement of the photography image data 1 and the photography image data 2.
[Drawing 7] It is the block diagram having shown actuation of a dedicated purpose computer.
[Drawing 8] It is drawing having shown adjustment of the photography image data 1 and the photography image data 2.
[Drawing 9] It is the flow chart which showed actuation of this three dimensional image gaging system.
[Description of Notations]
10 Digital Three-Dimensions Former Image Gaging System
12 Device under Test
20 Moire Camera
26 Three-Dimensions Displacement Gage
30 Dedicated Purpose Computer
32 Solid Image Processor

[Translation done.]

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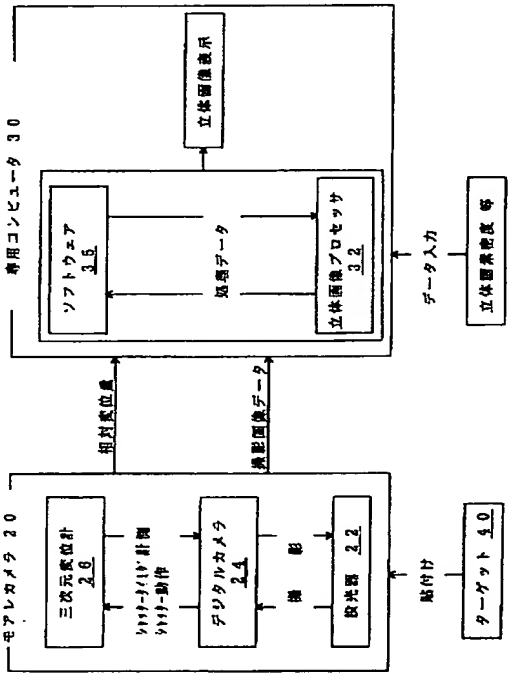
(54)【発明の名称】　デジタル三次元画像測定システム

(57)【要約】
【課題】　二次元又は三次元形状を有する被測定物を画像表示する三次元画像計測システムにおいて、簡易な測定で高精度な立体画像を短時間で得ることが可能な三次元画像測定システムを提供すること。
【解決手段】　三次元変位計２６を備えた携帯可能なモアレカメラ２０と、該モアレカメラ２０によって撮影された被測定物１２の撮影画像データを演算処理する画像プロセッサ３２を備えた専用コンピュータ３０とを備え、該３次元変位計２６でもって該撮影画像データから被測定物１２における相対変位量を求め、更に専用コンピュータ３０でもって該撮影画像データから特徴形状及び既知形状を有する部位を抽出し各々平均化処理した後、各々の撮影画像データを画像プロセッサ３２で合成し立体画像を得る。



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【特許請求の範囲】

【請求項１】　被測定物を撮影する携帯可能なデジタルビデオカメラと、該デジタルビデオカメラによって撮影された該被測定物の撮影画像データを演算処理する演算処理装置とこの演算処理した撮影画像データを基に三次元画像を立体表示する画像プロセッサとを備えるデジタル三次元画像測定システムにおいて、該デジタルビデオカメラによって被測定物を撮影して複数の撮影画像データを得る撮影画像取得手段と、該撮影画像データ取得手段をもって得た複数の画像データを該演算処理装置に取り込んで演算処理する画像データ演算処理手段と、該演算処理手段をもって処理した各々の撮影画像データを合成して作成した立体画像を表示する立体画像作成表示手段とを備えることを特徴とするデジタル三次元画像測定システム。

【請求項２】　前記撮影画像取得手段が三次元変位検出器と三次元角度検出器と三次元加速度検出器からなる三次元変位計とを備えたデジタルビデオカメラを用いると共に、これらの検出器をもって前記複数の撮影画像データから該撮影画像データ間の移動量を算出する撮影画像データ移動量算出手段と、この算出手段をもって算出した移動量から該デジタルビデオカメラと被測定物との相対変位量を算出する相対変位量算出手段を備えることを特徴とする請求項１に記載するデジタル三次元画像測定システム。

【請求項３】　前記画像データ演算処理手段が、前記撮影画像取得手段によって得られた複数の撮影画像データの各々において被測定物の特徴形状を有する部分を抽出する特徴形状抽出手段と、これによって抽出された特徴形状から更に円形状や四角形状等の既知形状を選出する既知形状選出手段と、該既知形状選出手段によって選出された該複数の撮影画像データの各々における特徴形状部分又は既知形状の同一部分同士を重ね合わせて該複数の撮影画像データを整合する撮影画像データ整合手段と、これによって整合した撮影画像データと前記相対変位量とに基づいて三次元画像作成することを特徴とする請求項１及び２に記載の三次元画像測定システム。

【請求項４】　前記被測定物の表面形状が平面で凹凸等の特徴形状となる部分がない場合には、該被測定物の表面上に補助部材を複数個取付けて被測定物の形状特徴とすることを特徴とする請求項１に記載のデジタル三次元画像測定システム。

【請求項５】　前記被測定物が可動している可動物体である場合は、被測定物の表面上に三次元変位検出器を取付けて撮影することを特徴とする請求項１、２、３及び４に記載のデジタル三次元画像測定システム。

【請求項６】　被測定物を撮影する携帯可能なデジタルビデオカメラと、該デジタルビデオカメラによって撮影された該被測定物の撮影画像データを演算処理する演算処理装置とこの演算処理した撮影画像データを基に三次元画像を立体表示する画像プロセッサとを備えるデジタル三次元画像測定システムにおいて、該デジタルビデオカメラによって被測定物を撮影して複数の撮影画像データを得る撮影画像取得手段と、該撮影画像データ取得手段をもって得た複数の画像データを該演算処理装置に取り込んで演算処理すると共に該演算処理には空間ＦＦＴを用いて処理する撮影画像データ演算処理手段と、該撮影画像データ演算処理手段をもって処理した各々の撮影画像データを合成して作成した立体画像を表示する立体画像作成表示手段とを備えることを特徴とするデジタル三次元画像測定システム。

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【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、デジタル三次元測定システムに関し、更に詳しくは被測定物を撮影して得た複数の撮影画像データを重ね合わせて立体画像を合成表示する際に、該撮影画像データを演算処理することによって、高精度な立体画像を短時間で表示することが可能なデジタル三次元画像測定システムに関するものである。

【０００２】

【従来の技術】従来、二次元形状又は三次元形状を有する被測定物を撮影し、その撮影画像をコンピュータ等の画面上で数値モデル化したり立体画像として表示するには、その撮影画像データの精度を向上させるためにＣＣＤカメラ等が用いられる。このＣＣＤカメラを用いた被測定物の立体画像の表示方法は、先ず、該ＣＣＤカメラを予め設けられた位置決め装置等に設置すると共に、該被測定物を予め設定された測定位置に設置し、該被測定物を二箇所から撮影する。この撮影によって得た複数の撮影画像データの各々から、被測定物の曲部分の計測点を複数得ると共に該曲部分の曲率を計算し、この計算処理した撮影画像データを合成して該被測定物の数値モデルや立体画像を得るものである。

【０００３】また、前記方法の他に光学式の方法を用いるものもある。この方法では、該被測定物の表面上に所定の補助対象物を複数貼付した後、光源を用いて該被測定物上へ光を照射する。この光照射によって該被測定物上には反射光が生じると共に該補助対象物による光影が生じることになり、これをＣＣＤカメラでもって撮影する。そして、該撮影によって得た複数の撮影画像データをデジタル撮像素子でもって検知処理し、この検知処理した複数の撮影画像データを合成して立体画像を得るものである。

【０００４】

【発明が解決しようとする課題】しかしながら、前記したように予め設けられた位置決め装置等にＣＣＤカメラを設置して被測定物の立体画像を得る方法においては、該ＣＣＤカメラを設置する位置決め装置が高価であったり、その構成が大がかりであることから、ＣＣＤカメラ

を位置決め装置に設置してから撮影を開始するまでに時間を要する。又、ＣＣＤカメラの携帯が困難であることから被測定物が余り大きくては撮影に無理が生じてしまうため、被測定物の大きさや形状が制限されてしまうといった問題があった。

【０００５】加えて、前記被測定物を撮影して得た撮影画像データから被測定物の曲部分の曲率を算出するには、その撮影画像データの精度が大きく影響するため精度のよい曲率を算出することは困難であり、更にその算出には時間を要する。又、該曲率の算出に用いる被測定物の曲部分の計測点位置や、その計測点の個数等の取り方が前記曲率の算出に大きく影響することから、算出した曲率の精度及び立体画像の精度にばらつきが出てしまい信頼性に欠けるという問題があった。

【０００６】更に前記した光学式の方法においては、被測定物上に所定の補助対象物を貼付しなければならないことから手間を要し、これも又、撮影を開始するまでに時間を要することになる。そして、該補助対象物を被測定物上に貼付する際には、その貼付位置が立体画像の精度に大きく影響するため、この方法においても前記したように精度にばらつきが出て信頼性に欠けてしまう。又、被測定物の表面上に光照射を行ってその光影を得る際には光源となる光に光干渉が生じやすく、この光干渉による影響を軽減させることが困難である等の問題があった。

【０００７】そこで本発明が解決しようとする課題は、二次元形状又は三次元形状等の立体形状を有する被測定物の立体画像を得るにあたって、その精度を向上させて高精度の立体画像を得ることが可能なデジタル三次元画像測定システムを提供することである。

【０００８】

【課題を解決するための手段】この課題を解決するために、本発明のデジタル三次元画像測定システムは、被測定物を撮影する携帯可能なデジタルビデオカメラと、該デジタルビデオカメラによって撮影された該被測定物の撮影画像データを演算処理する演算処理装置とこの演算処理した撮影画像データを基に三次元画像を立体表示する画像プロセッサとを備えるデジタル三次元画像測定システムにおいて、該デジタルビデオカメラによって被測定物を撮影して複数の撮影画像データを得る撮影画像取得手段と、該撮影画像データ取得手段をもって得た複数の画像データを該演算処理装置に取り込んで演算処理する画像データ演算処理手段と、該演算処理手段をもって処理した各々の撮影画像データを合成して作成した立体画像を表示する立体画像作成表示手段とを備えることを要旨とするものである。

【０００９】上記記載の発明によれば、デジタル式で且つ携帯可能なデジタルビデオカメラと該被測定物の撮影画像データを演算処理する演算処理装置と該演算処理された撮影画像データを基に三次元画像を立体表示する画像プロセッサを備え、該デジタルビデオカメラによる撮影画像取得手段によって複数の撮影画像データを得ると共に、これによって得た複数の撮影画像データを該演算処理装置による画像データ演算処理手段をもって演算処理し、これを更に立体画像作成表示手段によって該撮影画像データを合成して立体画像を表示する。これによって、撮影画像データを精度よく得ることが可能となると共に短時間で演算処理ができることから、被測定物の立体画像を高精度で且つ短時間で得ることが可能となる。

【００１０】そしてこの時には、請求項２に記載の発明のように、デジタルビデオカメラに三次元変位検出器と三次元角度検出器と三次元加速度検出器とからなる三次元変位計を備える共に、これらの検出器による検出値を基に撮影画像データ移動量算出手段をもって撮影画像データ間の移動量を算出し、更にこの移動量から該デジタルビデオカメラと被測定物間における相対変位量を求めるとよい。これによって精度のよい撮影画像データが得られることになり、高精度な立体画像が得られることになる。

【００１１】更に、請求項３に記載の発明のように、前記複数の撮影画像データの各々において特徴形状抽出手段をもって被測定物の特徴形状を抽出し、更に円形状や四角形状等の既知形状を既知形状抽出手段をもって抽出する。そして、この抽出された特徴形状及び既知形状の同一部分を撮影画像データ整合手段をもって重ね合わせ、この重ね合わせた撮影画像データと前記相対変位量とをもって被測定物の三次元画像を作成するとよい。これによって複数の画像データの整合が効果的に然も精度良く実施できることから、高精度な立体画像が得られることになる。

【００１２】そして、請求項４に記載の発明のように、前記被測定物の表面形状が平面で凹凸等の特徴形状となる部分がない場合には、該被測定物の表面上に補助部材を複数個取付けて被測定物の形状特徴とし、又、請求項５に記載の発明のように、前記被測定物が可動している可動物体である場合は、被測定物の表面上に三次元変位検出器を取付けて撮影するとよい。これによって被測定物の形状や停止又は可動等の状況を選ばずに撮影が可能となり、効率的である。又、撮影によって得られる撮影画像データも高精度であることから結果として高精度な立体画像が得られる。

【００１３】また、請求項６に記載の発明は、被測定物を撮影する携帯可能なデジタルビデオカメラと、該デジタルビデオカメラによって撮影された該被測定物の撮影画像データを演算処理する演算処理装置とこの演算処理した撮影画像データを基に三次元画像を立体表示する画像プロセッサとを備えるデジタル三次元画像測定システムにおいて、該デジタルビデオカメラによって被測定物を撮影して複数の撮影画像データを得る撮影画像取得手段と、該撮影画像データ取得手段をもって得た複数の画

像データを該演算処理装置に取り込んで演算処理すると共に該演算処理には空間ＦＦＴを用いて処理する撮影画像データ演算処理手段と、該撮影画像データ演算処理手段をもって処理した各々の撮影画像データを合成して作成した立体画像を表示する立体画像作成表示手段とを備えることを要旨とするものである。

【００１４】上記記載の発明によれば、デジタル式で且つ携帯可能なデジタルビデオカメラと該被測定物の撮影画像データを演算処理する演算処理装置と該演算処理された撮影画像データを基に三次元画像を立体表示する画像プロセッサを備え、該デジタルビデオカメラによる撮影画像取得手段によって複数の撮影画像データを得ると共に、これによって得た複数の撮影画像データを該演算処理装置の空間ＦＦＴによる画像データ演算処理手段をもって演算処理し、これを更に立体画像作成表示手段によって該撮影画像データを合成して立体画像を表示する。これによって、撮影画像データを精度よく得ることが可能となると共に短時間で演算処理ができることから、被測定物の立体画像をより一層の高精度且つ短時間で得ることが可能となる。

【００１５】

【発明の実施の形態】以下、本発明の好適な一実施の形態を例にとり、図面を参照して詳細に説明する。尚、本実施例においては被測定物を撮影するデジタル式のビデオカメラにモアレカメラを用いるものとし、被測定物は可動しない停止物であるとする。図１は、本発明の一実施の形態に係るデジタル三次元画像測定システムの構成図を示している。このデジタル三次元画像測定システム１０は、大別して被測定物１２を撮影してその撮影画像データを得るモアレカメラ２０と、その撮影画像データを処理する専用コンピュータ３０によって構成される。

【００１６】前記モアレカメラ２０は、その内部に光の陰影による格子模様であるフリンジ（モアレ模様）を被測定物１２上に照射する投光器２２と、該照射されたフリンジを撮影する工業用途のＣＣＤデジタルカメラ２４、そして該被測定物１２におけるモアカメラ２０の相対変位量を算出するための三次元変位計２６が設けられる。尚、その仕様は撮影範囲２００ｍｍ×１６０ｍｍ、立体画像の精度±０．１ｍｍ、分解能６／１００、重量１．５ｋｇの有線方式でもって構成される。

【００１７】前記投光器２２は、その光照射を行うための光源のレンズに前記フリンジ（モアレ模様）が設けられたガラスを有し、このガラスを介して光照射を行うことによって被測定物１２上に該フリンジが投光される。そして、前記ＣＣＤデジタルカメラ２４でもって被測定物１２を撮影することによって、該フリンジの状態を撮影することになる。

【００１８】また、前記三次元変位計２６は、図示しない三次元変位検出器と三次元角度検出器と三次元加速度検出器によって構成される。そして、前記フリンジを投影した被測定物１２を前記モアレカメラ２０に設けられたＣＣＤデジタルカメラ２４でもって少しずつずらしながら撮影し、その撮影画像データにおける被測定物１２の同一部位をもって該モアレカメラ２０の移動量（変位量）を算出する。この変位量を基にして、該ＣＣＤデジタルカメラ２４におけるシャッターを切るのに最適なタイミングを自動的に計算すると共に、連続したシャッター動作を自動的に行う。尚、この三次元変位計２６は精度３％、重量３００ｇの有線方式で構成される。

【００１９】また、前記専用コンピュータ３０は、前記モアレカメラ２０によって撮影された撮影画像データを演算処理すると共に、該演算処理した撮影画像データを合成処理して三次元の立体画像を表示する画像プロセッサ３２が設けられる。これによって、該モアレカメラ２０によって撮影された複数の被測定物１２の撮影画像データは、該モアレカメラ２０と該専用コンピュータ３０とは有線方式で接続されていることから逐次専用コンピュータ３０に自動的に取込まれて演算処理され、その後、該立体画像プロセッサ３２において合成されるように構成される。

【００２０】尚、前記被測定物１２が前記モアレカメラ２０でもって撮影を行う際にも動いているような可動物体である場合は、被測定物１２の表面上に前記三次元変位計２６と同じ図示しない三次元変位計を取付ける。そして又、前記被測定物１２の形状が平面形状や平たんで主立った特徴がないような場合には、該被測定物１２の表面上に所定の２次元形状、又は、立体形状で構成されたターゲット４０を被測定物１２の形状の補助部材として複数個貼付け、これを前記したと同じ方法をもって撮影するとよい。

【００２１】図２は、前記図１に示したデジタル三次元画像測定システム１０の構成をブロック図にて示している。尚、図中の矢印方向はデータの入出力方向を示している。図示するように、モアレカメラ２０は投光器２２、ＣＣＤデジタルカメラ（デジタルカメラ）２４、三次元変位計２６によって構成される。そして既述したように、前記モアレカメラ２０に設けられた投光器２２によって被測定物１２上に投光されたフリンジ（モアレ模様）をデジタルカメラ２４でもって撮影し、この撮影したフリンジを該モアレカメラ２０に設けられた図示しない解析用ソフトウェアでもって演算処理することになる。

【００２２】尚、前記モアレカメラ２０でもって被測定物１２を撮影する際には、予め該モアレカメラ２０の撮影位置と被測定物１２の設置位置との大凡の距離を与える。そして、該モアレカメラ２０でもって該被測定物１２の撮影部位をオーバーラップするように移動しながら撮影するとよい。

【００２３】そして前記したように、オーバーラップするようにして撮影した複数の撮影画像データから、モア

レカメラ２０が移動した移動距離と該撮影画像データを基に算出した角度変化から被測定物１２における相対変位量を算出する。この算出した相対変位量を基にＣＣＤデジタルカメラ２４のシャッターを切るタイミングを計測してシャッターを切る。尚、これらの該シャッターを切るタイミングの計測及びシャッター動作は、全て自動的に行われる。これによって効率的にシャッタータイミングが計測できると共に、その撮影枚数も最小限に押さえることが可能となる。

【００２４】前記相対変位量及び、前記モアレカメラ２０によって自動的に撮影された撮影画像データは、そのシャッター動作によって一撮影画像データが得られる毎に該撮影画像における空間座標位置の検出精度を向上するために補完された後、逐次専用コンピュータ３０に送られる。但し、この場合の立体画素密度等のデータは対話型形式でもって操作員が入力するように構成される。

【００２５】そして、前記専用コンピュータ３０におけるソフトウェア３５でもって先の一撮影画像データ毎に、前記被測定物１２における撮影画像データの法線方向において特徴的な形状を有する部位を抽出する。この特徴部位の抽出は、被測定物１２の形状における突起部分等の他、円形状等の曲平面や円柱、更には四角形状や三角形状等の平面形状、いわゆる既知形状を抽出する。

【００２６】但し、前記既知形状の特徴抽出の際に四角形状や三角形状等の平面形状は自動的に抽出されるが、極平面や円柱形状等のいわゆる円形状は、操作員が選択抽出することになる。尚、この特徴抽出時における円形状の判別度や抽出する個数等の認識度は操作員によって異なるが、ここで選択抽出された円形状の多少やその抽出箇所及び個数等によっては、最終的に立体画像が得られるまでに多少な時間差が生じることになる。

【００２７】そして、前記抽出された既知形状が撮影されている各々の撮影画像データにおいて、同一の既知形状を最小二乗法等の計算を用いて平均化処理して、この既知形状が最も一致する変位量を計算する。ここで算出した変位量に基づいて該撮影画像データを１つずつ立体画像プロセッサ３２上でもって重ね合わせて合成すると共に、この合成した画像を再度専用コンピュータ３０に送り、該専用コンピュータ３０の画面上に三次元の立体画像を表示することになる。

【００２８】尚、前記被測定物１２の撮影に際には、該被測定物１２の形状が既述したような特徴を有するかを確認し、該被測定物１２の形状が平面及び平坦な形状で特徴が見られないような場合には、被測定物１２の表面上にターゲット４０を複数枚貼付けて形状特徴として用いると良い。又、該被測定物１２が可動物体である場合は、既述したように被測定物１２上に三次元変位計を取付ける。但し、被測定物１２が停止している場合には、この三次元変位計は取付けずに省略しても良い。

【００２９】また前記モアレカメラ２０で撮影した撮影画像データ及び相対変位量等のデータの授受は、フロッピーディスク等の記憶媒体を用いて授受するようにしてもよい。そして、前記立体画像プロセッサ３２によって合成する立体画像の精度をより高くするためには、該立体画像プロセッサ３２で画像データの合成処理を行う際に複数の立体画像を重ね合わせて画像平均化処理を行うと、より高精度な立体画像が得られることになる。

【００３０】図３は、前記図１に示した三次元変位計２６に備えられる図示しないマイクロ容量式加速度検出器（以下、単に「加速度検出器」という。）の制御回路図を示したブロック図である。図中に示す矢印方向は信号が出力される方向を示している。また、図４には該図３に示した各制御回路における信号のタイミングチャートを示している。この加速度検出器５０は、前記モアレカメラ２０をもって撮影した撮影画像データにおけるモアレカメラ２０の移動量（変位量）を測定する加速度センサ５１が設けられ、発信器５２、基準電圧５３及び積分器５４と接続される。

【００３１】また、前記発信器５２は同期回路５５と接続され、ホールド・リセット回路５６を介して積分器５４に接続される。尚、この積分器５４には温度検出器５７が接続され、所定の温度を検出した場合に積分器５４に対して出力信号を送信する。

【００３２】前記加速度センサ５１及び基準電圧５３、ホールド・リセット回路５６並びに温度検出器５７から信号を受信した積分器５４は、これらのデータを制御処理し、切替器６０を介してＡ／Ｄ（Ａ／Ｄ変換器）６２に対して前記処理データを出力する。そして、Ａ／Ｄ変換器６２によって出力信号をアナログ又はデジタル信号に変換する。ここで変換された信号はマイクロプロセッサ６１に出力され、Ａ／Ｄ変換器６２はマイクロプロセッサ６１からの出力を得ることになる。

【００３３】前記マイクロプロセッサ６１は、Ａ／Ｄ変換器６２からのサンプリングを受ける毎に過去一定期間における値の平均値、又は近い過去ほど重みを加えた平均値を求める。これにより高応答性で且つ高精度の加速度が得られることになる。そして図４に示すように、加速度センサ５１の出力に対して並列にホールド回路５６及びリセット回路５６、積分器５４の出力を挿入すれば（正論理の部分の積分値）－（負論理の部分の積分値）応答速度が２倍となり、前記三次元変位計２６の応答速度が向上し、既述したデジタルカメラ２４のシャッタータイミング計測やシャッター動作が応答性能が向上する。

【００３４】図５は、前記図１及び図２に示したモアレカメラ２０における作動をブロック図にて示している。既述したように、前記被測定物１２をモアレカメラ２０でもって撮影すると、そのシャッタータイミング及びシャッター動作が自動的に行われ複数の撮影画像データ（例えば、撮影画像データ１、撮影画像データ２・・）

が得られる。そして既述したように、該複数の撮影画像データから被測定物１２における相対変位量が算出される。

【００３５】前記複数の撮影画像データ（撮影画像データ１、撮影画像データ２・・）の各々は、その撮影画像データ（撮影画像データ１、撮影画像データ２・・）における各々の画素毎に三次元の空間座標点が算出される。そして、図６に示すように各々の撮影画像データ（撮影画像データ１、撮影画像データ２・・）を前記算出した相対変位量に基づいて補完する。この補完された複数の撮影画像データ（撮影画像データ１、撮影画像データ２・・）と前記相対変位量は、逐次専用コンピュータ３０に送られることになる。

【００３６】図７は、前記図２に示した専用コンピュータ３０における作動をブロック図にて示している。前記図５に示したように、補完された複数の撮影画像データ（撮影画像データ１、撮影画像データ２・・）は、その１つの撮影画像データ毎に逐次専用コンピュータ３０に取込まれる。そして、この撮影画像データ毎に画像の法線方向に対して凹凸等の形状特徴を有する部位を抽出し、前記三次元の空間座標点を逐次比較して特徴点群を抽出する。更に各々の撮影画像データの曲部位における曲率分布をハッシュ法及びモンテカルロ法等の手法を用いて処理することによって特徴点群を分類し、曲率が小さい部位を多面体若しくは自由曲面をもって近似する。

【００３７】そして既述したように、前記撮影画像データの特徴形状において円形及び円柱形状等の既知形状を有する部位を操作員が選択し抽出する。但し、この既知形状の抽出は、直線等の平面においては専用コンピュータ３０によって自動的に抽出されることから操作員による選択抽出は必要としない。又、操作員が該円形及び円柱形状等の選択抽出を行う場合は、その形状に対する判別の基準に個人差があるため、その抽出に要する時間及び以後の処理に要する時間は一律ではない。

【００３８】例えば、同一の撮影画像データにおいて、全く円形や円柱形状を選択抽出しなかった場合と円形状及び円柱形状を複数選択抽出した場合とを比較すると、後述する立体画像を表示するための収束計算は、複数の円形状及び円柱形状を選択抽出した場合の方が早く収束することから、三次元の立体画像は円形状及び円柱形状を複数選択抽出した場合の方が早く得られることになる。

【００３９】また、既述したように各撮影画像データ（撮影画像データ１、撮影画像データ２・・）における既知形状部位の選択抽出は、前記被測定物１２において設定された精度部分を選択抽出するとよい。該被測定物１２は、その製作時において予め精度をもって設計する部分が設定されている。この精度を有する部分は、被測定物１２の形状データによって予め解っていることから、この精度部分を既知形状の部位の選択抽出に用いることによって、後述する収束計算が確実に収束し高精度の立体画像が得られることになる。

【００４０】そして、前記抽出した形状特徴及び既知形状の精度から「重み」値を考慮し、更にこの「重み」値における誤差の範囲である誤差見込み量を得て、評価関数を用いて評価する。尚、この「重み」値は被測定物１２の形状や材質等の種類によって異なることから、被測定物１２に応じて設定することになる。

【００４１】更に、前記誤差見込み量の範囲内において、前記抽出した形状特徴及び既知形状を最小二乗法等の計算を用いて平均化処理する。そして、この形状特徴及び既知形状の位置が最も良く一致する変位量を計算し、該変位量を初期値として前記評価関数の値が最小になるように収束計算を行う。そして、図８に示すように、各々の撮影画像データ（撮影画像データ１、撮影画像データ２・・）に含まれる前記形状特徴及び既知形状を重ね合わせて、各々の撮影画像データ（撮影画像データ１、撮影画像データ２・・）合成することになる。

【００４２】図９は、本三次元画像測定システム１０における作動を示したフローチャートである。被測定物１２の撮影にあたっては、先ず、その形状に特徴となるような形状を有しているか否かを確認し、凹凸やその他特徴となるような部位を有している場合（Ｓ１０「ＹＥＳ」）はターゲット４０の貼付は必要としないが、前記特徴となる部位を有していない場合（Ｓ１０「ＮＯ」）は、被測定物１２の表面上に所定のターゲット４０を複数貼付して（Ｓ１２）、被測定物１２の特徴形状として用いる。

【００４３】また、前記被測定物１２が撮影時にも可動している可動物体である場合（Ｓ１４「ＮＯ」）は、該被測定物１２上にも三次元変位計を取付ける（Ｓ１６）。但し、前記被測定物１２が停止している停止物体であれば（Ｓ１４「ＹＥＳ」）、この三次元変位計を取付けなくともよい。

【００４４】更に、前記モアレカメラ２０と被測定物１２との大凡の距離、及び画素密度等のデータを対話形式でもって入力（Ｓ１８）し、モアレカメラ２０でもって被測定物１２をオーバーラップするようにずらしながら撮影する（Ｓ２０）。既述したように、該モアレカメラ２０で被測定物１２の撮影を開始すると、モアレカメラ２０に設けられた投光器２２からフリンジ（モアレ模様）が該被測定物１２上に投光され、このフリンジをＣＣＤデジタルカメラ２４でもって撮影して撮影画像データを得る。

【００４５】尚、ＣＣＤデジタルカメラ２４のシャッターを切るタイミング計測及びシャッター動作は、前記図２に既述したように、前記モアレカメラ２０に設けられた三次元変位計２６によって算出された相対変位量に従って自動的に行う。これによって撮影された複数の撮影画像データは、前記図５に示したように、その各々の撮

影画像データ毎にデータが補完され、該相対変位量と共に専用コンピュータ３０に逐次送られることになる（Ｓ２２）。

【００４６】そして、前記専用コンピュータ３０に送られた複数の撮影画像データは、前記図７に示すように、その各々の撮影画像データにおける被測定物１２の形状特徴部位及び既知形状を選択抽出すると共に各々を平均化処理（Ｓ２４）する。そして、該抽出した特徴部位及び既知形状の部位が最も一致するするように、前記撮影画像データを１つずつ立体画像プロセッサ３２で重ね合わせて合成した（Ｓ２６）後に再度専用コンピュータ３０に送り、該専用コンピュータ３０の画面上に三次元の立体画像を表示することになる。

【００４７】このように、複数の撮影画像データから被測定物における特徴形状を有する部位や円形状等の既知形状を選択抽出し、更にこれらの法線方向における誤差を二乗平均して得られる近似値が所定の誤差範囲内であれば、高精度な立体画像が得られる。つまり、前記撮影画像データから選択抽出した特徴形状や既知形状を整合すると、前記撮影画像を重ね合わせて得る立体画像の整合も良いことから、その結果高精度な立体画像が得られることになる。

【００４８】また、図示しないが、本実施例における撮影画像データの演算処理には、空間ＦＦＴを用いた三次元画像測定装置を用いることも可能である。該空間ＦＦＴを用いた三次元画像測定装置は、市販のデジタルビデオカメラ等を用いて被測定物を撮影し、その撮影画像データをフロッピーディスクやＲＡＭ等の記憶媒体を用いてコンピュータに取り込んで演算処理し、三次元の立体画像を得るものであるが、この処理に空間ＦＦＴを用いるものである。

【００４９】前記空間ＦＦＴによる撮影画像データの処理は、被測定物の詳細な外輪郭抽出を可能とし、更に、コンピュータに取り込んだ該撮影画像データをボクセル処理することによって高精度の画像表示を得る。これによって、従来の撮影画像データから得られる濃淡情報に加えて、三次元における空間座標位置の情報も得ることから、より高精度な立体画像を得ることになる。

【００５０】本発明は、上記した実施例に何等限定されるものではなく、本発明の趣旨を逸脱しない範囲で種々の改変が可能である。例えば、本実施例においてはモアレカメラを用いたが、使用するカメラ及び周辺機器等は限定されず、また、撮影した被測定物の撮影画像データをコンピュータに取込む方法、撮影画像データによる特徴部位及び既知形状の抽出方法、抽出する既知形状、更に、立体画像の合成方法や、完成した立体画像の表示方法等の変更追加は随時可能である。

【００５１】

【発明の効果】以上説明したように、請求項１に記載の発明によれば、携帯可能なデジタルビデオカメラを用いることにより被測定物の形状や大きさ、更に可動又は停止等の状態等を問わずに撮影が可能となることから、被測定物を選ぶことなく効率的な撮影が実施できる。そして、この被測定物を撮影して得た撮影画像データを補完することによって各々の撮影画像データが高精度を有することになり、該撮影画像データを立体表示するまでに必要な工程における撮影画像データは、可能な限り高精度なデータが得られる。よって、高精度な三次元立体画像が得られることになる。

【００５２】そして、請求項２に記載の発明のように、ビデオカメラと被測定物との相対変位量を算出して撮影画像データの補完処理に用いると共に、更に請求項３に記載の発明のように、撮影画像データにおける特徴形状と既知形状とを選択抽出し、該相対変位量に基づいて各撮影画像データを整合すれば、各々の撮影画像データにおける収束計算が収束し易くなり、これにより演算処理に要する所要時間の短縮を図ることが可能となり、更に操作員の経験等を考慮しなくとも一定精度を備えた信頼性の高い立体画像が容易に得られることになる。

【００５３】更に、請求項４に記載の発明のように、被測定物の形状に特徴がないような場合には、その表面上に補助部材を設けると共に、更に請求項５に記載の発明のように、被測定物が可動物体である場合は、被測定物の表面上に三次元変位検出器を取付けるとよい。これによって被測定物を選ぶことなく精度の良い撮影画像データが得られる。そして又、このように被測定物の形状や状態等を考慮する必要がないことから、その用途も広がることになる。

【００５４】また、請求項６に記載の発明のように、被測定物の撮影画像データを空間ＦＦＴを用いて処理することによって、鮮明な立体画像を得ることが可能となる。尚、この撮影の際に用いるカメラは、市販のビデオカメラを用いると共に、これによって得た撮影画像データは、これも又、市販のフロッピーディスクやＲＡＭ等の記憶媒体を用いての移送が可能であることから、データの移送及びそれによる汎用が容易であり、又、効率的である。

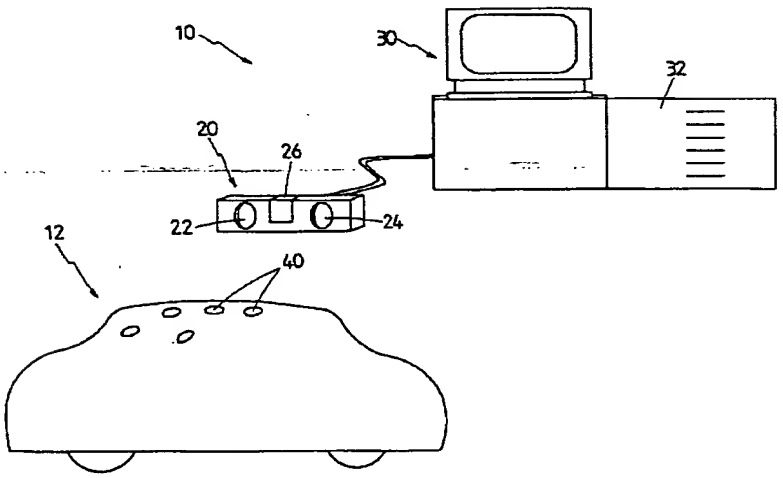
【００５５】そして、このように作成された立体画像は、前記撮影画像データにカラー画像を加えた画像情報を用いることにより、立体ＣＧデータを作成してアニメーションや仮想現実（バーチャルリアリティ）等を制作することが可能であると共に、道路や建物等を撮影して得る撮影画像データを用いて運転ナビゲーションシステムやシミュレーションシステム等を制作することも可能である。更に、機械装置や製品等における組立性の検証やゲーム等を制作することが可能であることから、その用途に幅広く対応することができる。

【図面の簡単な説明】

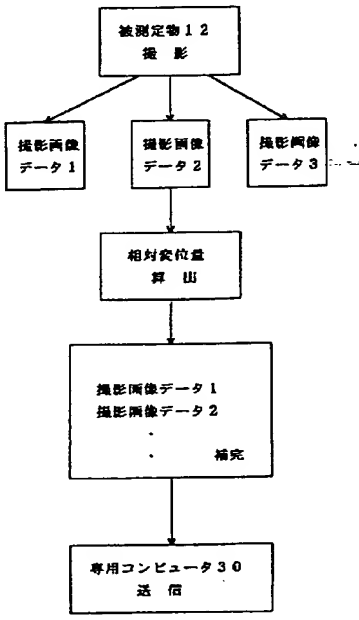
【図１】本発明の実施形態に係るデジタル三次元画像測定システムの構成図である。

【図２】図１に示したデジタル三次元画像測定システムの構成を示したブロック図である。
【図３】図１に示した三次元変位計に備えられるマイクロ容量式加速度検出器の制御回路図を示したブロック図である。
【図４】図３に示した各制御回路における信号を示したタイミングチャートである。
【図５】モアレカメラの作動を示したブロック図である。
【図６】撮影画像データ１及び撮影画像データ２の補完を示した図である。
【図７】専用コンピュータの作動を示したブロック図で＊ある。
【図８】撮影画像データ１及び撮影画像データ２の整合を示した図である。
【図９】本三次元画像測定システムの作動を示したフローチャートである。
【符号の説明】
１０　デジタル三次元元画像測定システム
１２　被測定物
２０　モアレカメラ
２６　三次元変位計
３０　専用コンピュータ
３２　立体画像プロセッサ

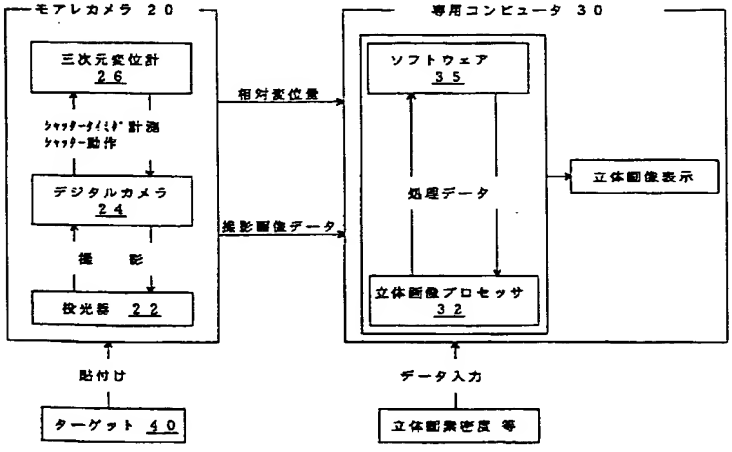
【図１】



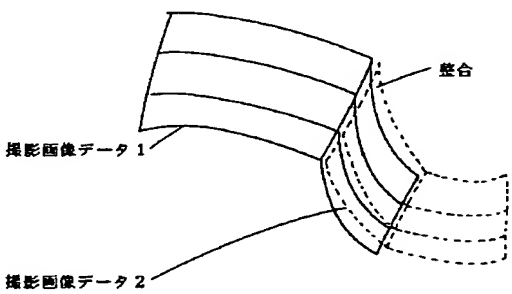
【図５】



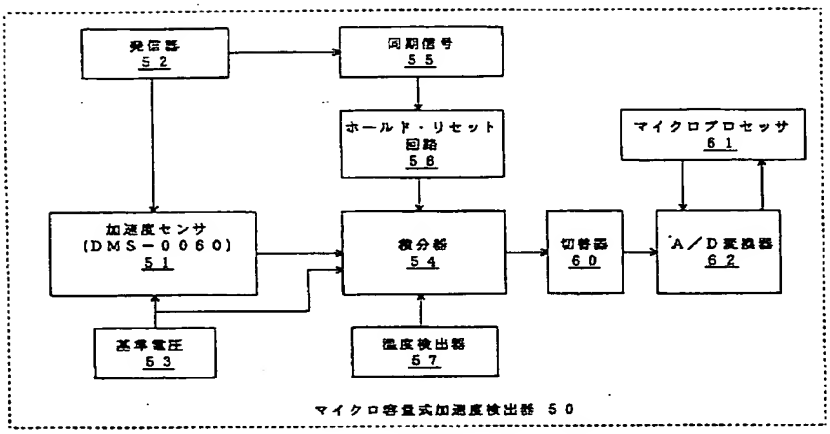
【図２】



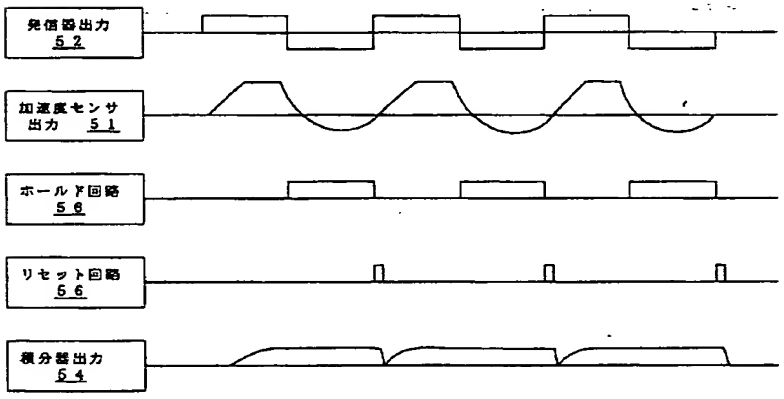
【図８】



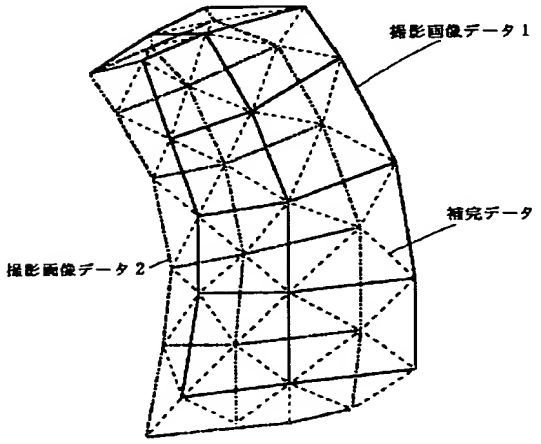
【図３】


発信器
５２
同期信号
５５
ホールド・リセット
回路
５６
マイクロプロセッサ
６１
加速度センサ
（ＤＭＳ－００６０）
５１
積分器
５４
切替器
６０
Ａ／Ｄ変換器
６２
基準電圧
５３
温度検出器
５７
マイクロ容量式加速度検出器　５０

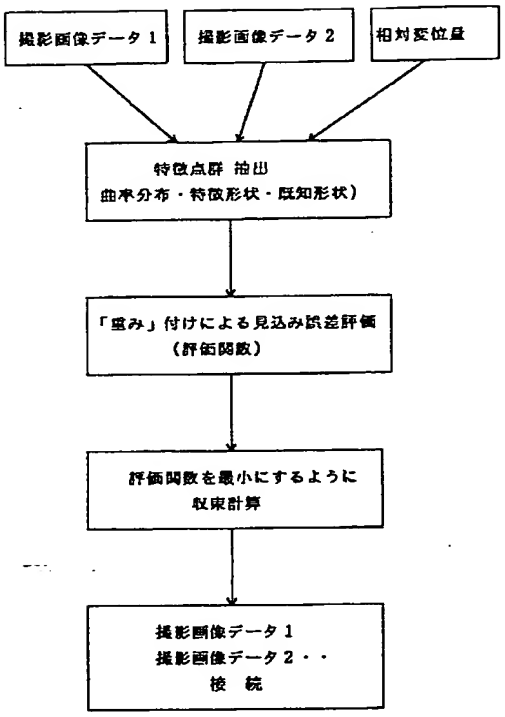
【図４】


発信器出力
５２
加速度センサ
出力　５１
ホールド回路
５６
リセット回路
５６
積分器出力
５４

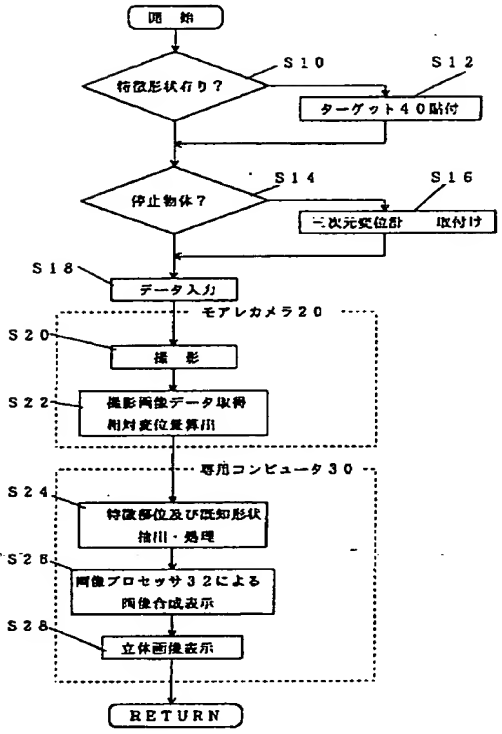
【図６】


撮影画像データ１
補完データ
撮影画像データ２

【図７】



【図９】



フロントページの続き

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